THE

ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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DUST AND THE SUMMER LOAD FACTOR.

By a curious inversion of natural processes, the anxieties of the central station manager are apt to be greater in the pleasant season of light loads and summer weather than amid the fogs and gloom of winter. Whether the responsible position in question be combined in one corporeal entity with that of chief engineer, or separate under a less strenuous exterior, the sight of the rows of machines lying day after day without contributing a single B.T.U. towards their living is very saddening to one whose mission in life is to find work for the idle. It has a cumulative influence, the Christmas peak insisting on an increased reserve, and the following summer setting forth points for the moral of the unemployed shareholder or fretful councillor.

With that same Christmas peak still to come, and some very nice altitudes daily ornamenting the records, it may seem that the present is no time to worry about next summer. In view, however, of this very fact, namely, that the minds of those actually engaged in the work are sufficiently occupied, it will not be wasting time to consider new means of providing against the dearth of occupation for the running plant before alluded to, in order to be able to lay before them some remedy whose application may be sufficiently apparent without prolonged discussion of details. Motor load the station engineer is already engaged in earnestly cultivating, with in many places the most beneficial results; but in small towns the fitful action of two or three large motors is apt to have an effect on the pressure very trying to the eyes. Lest it should be thought that this remark is unduly disparaging to that imperfect mechanical contrivance for converting 18s. per week into volts, the switchboard attendant, let us commend to any admirer of theoretical perfection the experiment of charging a battery with a 50-H.P. set, with a 40-H.P. printing machine motor in constant attendance, and a few smaller ones dropping in occasionally. What then would be the joy of the manager, chief and subordinate, to acquire a load of absolute steadiness which could be arranged to come on during the day, and that only during the summer months! Such an idea appears too Utopian for anything but a non-technical journal of the halfpenny variety. In the train of adverse circumstances, however, it is not only the unexpected, but frequently the impossible, that happens; surely the same should occasionally hold good for the other side of the shield.

One factor in the development of such a load was the subject of a paper read at the first meeting of the Faraday Society on Tuesday last week, describing the plant installed some twelve months ago by the Poplar Borough Council for the manufacture of hypochlorite of magnesium solution on the Hermite principle. This solution, which has, of course, been well known for a

number of years, is largely used on the Continent for disinfecting and medicinal purposes, and can be adopted for bleaching on a large scale. The slowness which it has shown in coming into general use is principally due to the initial expense of the necessary plant, as hitherto platinum has been the only metal which could be used for the anode plate. The processes of manufacture vary as to detail, but the general principle, the electrolysis of a saline solution, is common to all.

In connection with the use of this solution as a disinfectant (for the purpose of supplying which the erection of the plant in question was first recommended to the Council by Dr. Alexander, the medical officer of health), the question of street watering arises. The sterilising properties of the hypochlorite solution were proved in a general way in some experiments at Maidenhead, and increased proof of their value in this respect is daily being collected. As a deodorant it takes a very high place. Consequently, the admixture of a small quantity of the solution with the water used for laying the dust in summer is in every way beneficial, and advisable. The regrettable thing from the station engineer's point of view, as was pointed out by Mr. Smart, one of the speakers at the discussion, is that at present, the consumption of the fluid being comparatively small, only a small load can be expected from it. However, any load which will come on at regular hours, and remain perfectly steady throughout the day, is not to be despised, and it seems reasonable to hope that, as the valuable properties of such solutions become more widely known, large districts will be supplied from one centre, and so the installation of larger plants will be justified.

The same discussion included the valuable suggestion from Dr. Rideal that calcium chloride solutions, which have been used for dust laying with very satisfactory results, should be passed through electrolysers, and have part of the chloride present converted into hypochlorite. Water carts containing calcium chloride solutions have been effective because of the deliquescent character of the salt. Given a small quantity of available chlorine present in the form of calcium hypochlorite, not only will the dust be laid, but a surface sterilisation will be secured.

Cast-Iron and Steel-Tired Wheels.

THERE are evidences that the tide of American opinion is running in favour of steel tires for car-wheels. A recent article in the *Street Railway Journal*, by Mr. James Andrews, strongly supports them. This writer says that the cast-iron wheel was all right for the light horse cars, and was used with satisfaction on electric cars, until managers found that still greater satisfaction could be got from the steel wheel, whereupon they adopted it.

It was supposed at first that the brake-shoes would play havoc with the tires, but it is found actually that the wear from this cause is not so severe as with cast-iron wheels. This may be so in certain cases, but we doubt its being the general finding; and we have still greater difficulty in accepting the statement, which the writer himself says requires further corroboration, that the resistance of a steel tire to wear *increases* to a depth of about ½ in., then falls off a little, after which it remains constant at a value somewhat higher than at the surface of the tread.

Whether steel tires in England have the advantage that they keep cars longer out of the repair shop is an open question. In cases where the average life of a cast-iron wheel is over 17,000 miles there is not a great deal in it, because the flanges, at least, of steel tires want attention about the same time, and re-wheeling or re-tiring in any case is usually carried out when a car is brought in for its periodic overhauling. But under what different conditions the American approaches this question! Mr. Andrews shows us sections of wheel treads and flanges, of which the original contour has been preserved almost perfectly, whether of cast-iron or steel, and he says that as far as character of wear is concerned there is not much difference, while the miles per unit of wear are put at 3,500 per $\frac{1}{16}$ in. for cast-iron, and 5,500 per $\frac{1}{16}$ in. for steel. The Englishman then is wise who tests the still disputed point of precedence for himself.

Tube Railways and the Law of Compensation.

A CURIOUS point relating to the payment of compensation for interference by a tube railway company with the land of a leaseholder was raised in the recent case of R. *v.* Great Northern, Piccadilly and Brompton Railway Co. (*ex parte* Coburn), which was heard in the Divisional Court on October 25th. The railway company desired to drive their tube under certain premises which were subject to a lease which had some 68 years to run. The leaseholders demanded compensation on the ground that the letting value of their property would be diminished owing to the proximity of the railway. The parties having failed to come to terms, the assessment of the damages was left to a jury, who awarded some £1,200. They made no separate award for the value of the easement which was taken—namely, the easement to run trains under the claimant's land; and, as a matter of fact, the claimant or his witnesses told the jury that he attached no value to the land. The claimant now sought to have the verdict set aside, alleging that the jury should have valued the land. The interesting point was whether the jury were bound to attach some value to the land through which the tunnel was driven. The claimant frankly said, "It is of no value to me if I keep it; but inasmuch as the railway company cannot carry out their undertaking without it, it is of value to them, and I want something for it." Unfortunately the Court did not decide this curious point, because it was not specially laid before the jury, but the case is worthy of note inasmuch as it directs attention to the necessity for making a definite claim in respect of any land which may be taken compulsorily, howsoever deeply it may be situated. Whether the jury upon such an inquiry would be entitled to declare that the land had no value, and to award accordingly, is a question for a bench of judges to decide.

Electric Tramway By-laws.

IN a case relating to the Norwich Tramway By-laws in the Divisional Court last week, a novel point was raised. A passenger who was, in fact, an alderman of the town bought and paid for a ticket while he was on a car. Subsequently the vehicle becoming crowded, he was obliged to get up to give his seat to a lady, and when an inspector asked him to produce his ticket, he was unable to do so, as he had lost it. The inspector called upon him to pay again, which he refused to do. The conductor then appeared and gave the passenger the option either of paying again or leaving the car. He refused to do either, and was, in conse-

quence, summoned to appear at a police court. The by-laws provided that (*a*) a passenger must show his ticket when required; (*b*) a passenger who is unable to produce his ticket must purchase a new one. The justices held, as a fact, that the defendant having admittedly purchased and lost his ticket, he could not be compelled to buy another. From this decision the Corporation of Norwich, which owns the tramways, appealed, and a case in the Court of Appeal was cited in the Divisional Court to show that the by-laws in question had been upheld in the year 1896. The Lord Chief Justice expressed a strong view that the by-law was unreasonable. Mr. Justice Darling did not share this view, saying that if any passenger was able to say "I have lost my ticket," it would open the door to fraud. In the end the case was sent back to the justices, with an intimation that although the by-law was good, this was a case in which there should not be a conviction. We may point out, in reference to this case, a fact with which the public generally do not appear to be familiar, namely, that although a passenger may have to pay twice he can always claim the excess from the Corporation "as—to use the words of law—money paid without consideration." A postcard to the Corporation in the above case would have resulted in the receipt of a 1d. stamp, and all the trouble and costs would have been avoided.

Competition in Germany.

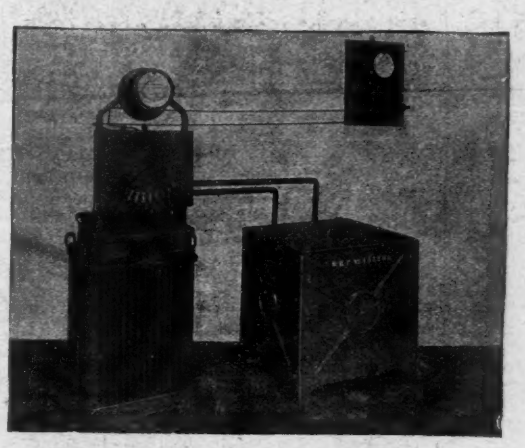
THE electrical engineering firms of medium dimensions in Germany have risen in their wrath against what is alleged to be the unfair competition which they have to suffer at the hands of the large firms, the number of which does not exceed half a dozen. At a recent meeting of the representatives of the former class in Berlin, the question of the "secret" syndicate of the large electrical companies was considered, and proposals were discussed for the purpose of meeting the measures said to be taken by the syndicate, which are declared to render it materially difficult and partly impossible for the second rank firms to compete. The conference first referred to the case of the town of Glogau, where the magistrate, after it had been proposed to give a contract for electricity works plant to one of the large companies, withdrew the proposal on the ground of the circumstances revealed, and decided to open a fresh competition. A second charge made is to the effect that the boiler and engine works, and the cable syndicate, systematically tender on terms which are more unfavourable to the medium electrical firms than to the large firms, the result being that the medium rank firms are compelled to requisition foreign engines, cables, &c., in order to remain in a position to compete. As an instance, it is mentioned that large quantities of cables have had to be obtained recently from Switzerland. The third point brought forward is in reference to the agreement made between a number of the second rank firms and the Berlin-Hagen Accumulator Co. in respect of the granting of a commission on the former's annual turnover in batteries. The second rankers declare that competition in stationary batteries is impossible for them, as the commission granted to the large or first rank firms by the same company materially exceeds that accorded to them. In the circumstances it is urged that it is not in the interest of the second rankers to renew the agreement. In conclusion, the conference appointed a committee of three to watch over the position of the second-rank firms, to endeavour to induce those concerned to take legal action in cases "in which the competition of the large firms cannot be approved," and to give wide publicity to any such cases in the newspapers. It will be a matter of interest to see whether the large electrical engineering companies will issue any reply to the above statements. It seems improbable that they will do so, having regard to the fact that the assertions have been made anonymously.

HARDENING AND ANNEALING BY ELECTRICITY.

ONE of the most interesting industrial applications of electricity shown by Mr. S. E. Fedden at the Corporation Electrical Exhibition in Sheffield during the last few weeks, was an electrically heated furnace for hardening steel. It is intended to replace gas and coke fires, or the lead and salt baths, at present used so extensively by toolmakers and cutlers.

The apparatus consists of a rectangular crucible built up of firebrick and clay within a cast-iron case. At opposite sides electrodes of wrought-iron are fixed, with massive connections well screened within the firebrick lining, which is of such thickness that the outer casing remains cool, and but little loss of heat takes place.

The bath is filled with crystals of pure barium chloride, which become molten by the passage of the current, and can be maintained uniformly at any temperature between 750° and 1,400° C. For the higher temperatures—1,100° to 1,400° C.—barium chloride alone is used, but for the lower range it is necessary to have a mixture of barium and potassium chloride. The cost of the charge is unimportant, ranging from 20s. to 30s. for the largest size furnace, which holds about 1 cwt. of salts.



THE ELECTRICAL COMPANY'S FURNACE WITH TRANSFORMER AND REGULATING SWITCH.

After being once used, the mixture sets solid, and has to be started up again by sprinkling fresh crystals across the bath from one electrode to the other, or by starting an arc against one electrode by means of a flexible conductor and a piece of carbon, when the adjacent salt will liquefy and spread until the whole is molten, the operation taking about half an hour to accomplish when the furnace is quite cold.

The use of alternating current prevents any electrolytic action and facilitates the pressure regulation across the bath, which is effected by means of a transformer with regulating switch on the primary windings. In the case in point the supply was given at 200 volts single-phase, 50 periods, and the pressure between the electrodes could be varied by fine steps from 10 to 20 volts.

With a steady pressure of supply an ammeter in the circuit affords a fairly reliable check upon the temperature of the bath, but in the experiments carried out, various forms of pyrometers by Siemens Bros. and the Cambridge Scientific Instrument Co. were used, enabling precise temperatures to be obtained. Previous experiments have shown that the temperature of the molten mass is perfectly uniform at every part of the bath and at any depth with the exception of a layer from 10 to 15 mm. thick on the top surface which is in contact with the air.

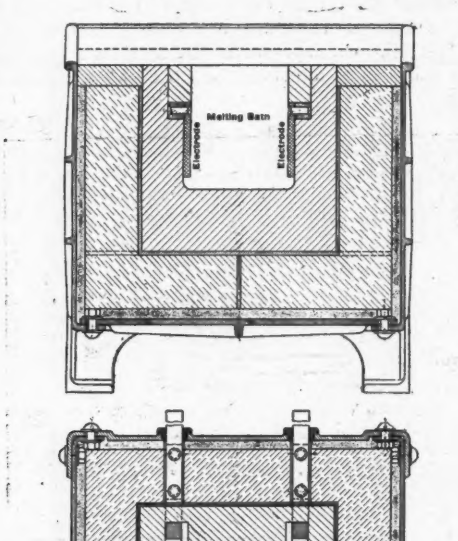
The correct temperature having been secured, the articles to be heated are lowered into the bath and are soon raised to the same heat with perfect uniformity throughout their mass irrespective of shape, and without the possibility of burning the finest edges or damage due to unequal expansion.

D

In this furnace the dimensions of the bath are 12 in. × 12 in. × 14½ in. and the energy consumption from 20 to 48 units per hour, according to the working temperature and the amount of material being operated upon. The rate of consumption is stated to vary from 4·10 watts at 750° C. to 49·20 watts at 1,300° C. per cb. in. of mixture in furnaces of medium size, the results being rather worse in small sizes, and better in large. Trials were made upon a variety of tools by local steel makers and engineers from the principal tool-making centres of the country.

With twist drills made of high-speed steels, most satisfactory results were obtained, the time taken in bringing them up to the required temperature, 1,300°—1,350° C., being very short. It was demonstrated that, with two men working, over 150 twist drills up to 1½ in. diameter could be successfully hardened in one hour.

Milling cutters, varying from 1½ in. diameter, and ¼ in. in thickness, to 6 in. diameter and 11 in. in length, were



Sectional Views of Electrically Heated Furnace.

treated. A cutter of the latter size was plunged into the bath without previous heating, and was brought up to the required temperature in 14 minutes, as against 1½ hours which would be required by the methods at present in use.

It was shown that the heating was regular, and had thoroughly permeated the tool, without causing stress or risk of cracking; no oxidisation took place, nor were the edges burnt in the slightest degree.

Lathe and planing tools gave similar results, many sizes up to 2 in. × 2 in. being hardened.

At lower temperatures, varying from 750°—1,000° C., high carbon steels were treated; files of all sizes and sections, wood-working tools, table knives, steels for knife sharpening, razor blades, springs and spring steel, steel wire, &c., and the results in all cases satisfied the manufacturers, who had obtained them with their own men accustomed to the usual gas or coke ovens.

Over 20 of these furnaces are at present in operation; and it is stated that with gas at 1s. 2d. per 1,000 cb. ft., and electricity at 1d. per unit, the actual cost of hardening is about the same for the latest forms of gas oven, and for the electrical furnace, but with the latter, faulty work is almost unknown, and the output per man is greatly increased. As the price of gas is frequently much above the figure cited, and electricity in large works often below 1d., this invention appears to be as worthy of the serious consideration of manufacturers, as it is of the attention of supply engineers, who will see in it a steady consumer of energy, and a further addition to the increasing sphere of usefulness for electricity in the workshop.

DIRECT COMPENSATION FOR ARMATURE REACTION IN ALTERNATORS.*

Practically all the recent improvements in both direct and alternating current machines are concerned with the compensation of armature reaction.

Large armature reaction is not in itself an unmixed evil, for it generally leads to an increase in efficiency and a reduction in weight of material. On the other hand, it tends to prevent sparkless commutation in direct current machines, and tends to make the voltage regulation of alternators bad.

Without special compensating devices, therefore, it has usually been necessary to underrate the machines simply in order to keep the armature reaction within the permissible limits. In the case of alternators, inductive loads are especially objectionable because they produce a weakening of the main field not proportional to the total armature current, but to the wattless component of this current. In some of the suggested methods of compounding it has, therefore, been necessary first to split up the output into its power and wattless components, and then to employ the latter (generally after rectifying it in some way) as the compensating agent. In this way costly additions to the alternator are involved, and these, in most cases, more than counterbalance the good effect of the compensation produced.

The new method of compensation suggested by Heyland is superior to these older methods in that (1) it can be applied to almost any existing alternator with little or no structural alteration, and (2) it compensates directly in proportion to the actual armature reaction produced (*i.e.*, it allows automatically and without special apparatus for the difference in reaction produced by inductive and non-inductive loads).

The method consists simply in using the alternator leakage field (which varies with the armature reaction) either to generate an additional exciting current directly, or, preferably, making this leakage field combine with the working field of the exciter so as to alter the exciting voltage automatically in accordance with the variations in alternator armature reaction. For every alternator load, the total field is the sum of the useful (armature) field and the leakage field. The leakage field depends, in the first place, on the design of the machine, but whatever its amount, it changes with load variations in strict proportion to the armature reaction or to the alternator voltage drop or, in other words, to the variation in excitation required in order to maintain constant terminal pressure.

If the alternator were fitted with a direct coupled exciter of the same type as itself (*e.g.*, both alternator and exciter having fixed magnets, and having the same number of poles) it would only be necessary to connect similar poles on the two machines magnetically, in order to superpose a field proportional to the alternator armature reaction on the normal exciter flux.

As it is usual to employ rotating field magnets with many poles for the alternator and fixed field magnets with few poles for the exciter, this method cannot be directly used. An equally simple method, however, is available in this case. It is only necessary to introduce a want of symmetry into the poles of opposite sign on the alternator in order to make the leakage field of one polarity greater than that of the opposite polarity, and so set up the equivalent of a unipolar leakage field. A part of this excess leakage field will travel along the spindle to the exciter armature, through this to the corresponding exciter field poles and back to the alternator by the bedplate or frame. In this way an additional flux varying with the alternator armature reaction will become effectively linked with the exciter armature conductors. The effect can be increased further by introducing a similar disymmetry into the exciter poles. Such unipolar leakage fields exist naturally in the case of inductor alternators and also in a type of alternate pole machine, which used to be common a few years ago, in which only every alternate pole was provided with a field winding.

Fig. 1 shows how the same effect can be produced in a normal alternator—viz., by reducing the air gaps at poles of one sign (say at all the south poles) and, preferably, also reducing the amount of field winding on these poles. The same result may be obtained by making the poles of different cross-sections, and so saturating some more than others.

Fig. 2 shows such a magnetically combined alternator and exciter, with the exciter built inside the frame of the alternator. Overhung exciters can, however, also be employed by making the want of symmetry rather greater, so as to enable the leakage field to travel back through the longer path in the bedplate. Suppose the want of symmetry is chosen so that with no load on the alternator, both S. pole and N. pole leakages are equal (this would be the case, for instance, if the turns on the S. poles were reduced in the same proportion as the air-gaps at the S. poles). Then at no load there would be no excess leakage along the spindle, and the exciter voltage would be simply that due to its own field. As the

* Abstract of an article by Alexander Heyland in the *E.T.Z.*, November 1st, 1906.

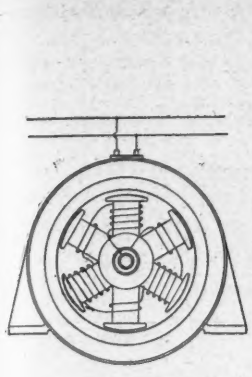
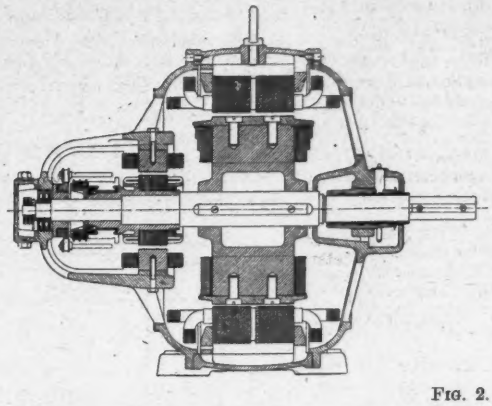


Fig. 1.



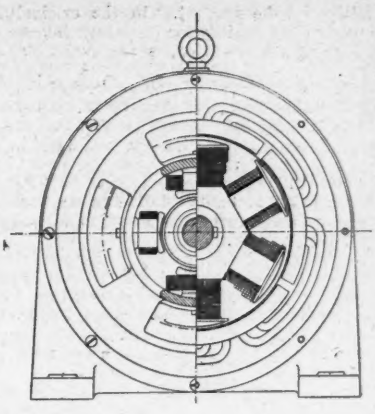


Fig. 2.

Direct Compensation for Armature Reaction in Alternators.

load increased, however, the effect of armature reaction would be greater at the weakly excited S. poles than at the N. poles, and an excess leakage would flow along the spindle in the direction corresponding to the alternator N. poles. This field would pass through the exciter and strengthen its S. poles (which, in order to increase the effect, should also have smaller air-gaps). It is obvious that the amount of this excess leakage need only be very small, as it will even then form a large proportion of the flux of the small exciter.

The above fundamental idea can also be employed when the alternator is quite separately excited (no direct coupled exciter). It is then only necessary to fit two collecting brushes on the spindle—one on each side of the magnet wheel—or on the edges of the magnet wheel itself, in order to have a direct current induced by means of the excess unipolar leakage flux. This current can then be used to help the alternator excitation, or it can be sent round a separate winding on the exciter field. The latter would be the preferable arrangement, since the low voltage induced by the unipolar field would otherwise involve the use of excessively heavy currents.

It would in most cases be advantageous to arrange the want of symmetry in the poles, so as to give some degree of negative compounding at no load. As the load increased, the compounding effect would first fall to zero, and then rise in a positive direction. This can be effected in the case shown in fig. 1 by making the air-gaps unequal, and also the turns unequal, but not in the same proportion. In this way only about half the maximum leakage field becomes necessary since it acts first in the negative, and then in the positive sense. Further, it is possible by this means to make the machine stable when supplying leading currents. In alternators compensated by any of the existing methods, a capacity load is liable to cause the compensating device to weaken the alternator field unduly, and so make the machine fall out of step. With the above arrangement, leading currents would cause the negative leakage field to increase, but since this increase would soon lead to saturation of the poles, it is quite limited in amount, and cannot produce instability.

In conclusion, the writer points out that the adoption of the new method will generally lead to a decided saving in field windings since unnecessarily large air-gaps are almost always employed in order to reduce the effects of armature reaction, and these would no longer be required. The arrangement cannot but improve the regulation of the machine even when no exact experiments are available for determining the correct proportions for exact level compounding. It is only necessary to introduce the disymmetry described, and then to run the machine up, and to excite it in one or the other direction. One direction will result in improved regulation, whilst the wrong direction will at once become apparent by increasing the voltage drop.

No experimental results are mentioned in the article.

PROCEEDINGS OF INSTITUTIONS.

The Faraday Society.

Electrolytic Hypochlorite. The Hermite Plant at Poplar.

The Faraday Society devoted its first meeting of the session, held on Tuesday, November 13th, at the Institution of Electrical Engineers, to the consideration of some of the problems involved in the electrolytic production of hypochlorite solution, now coming rather largely into use for deodorising and sterilising sewage, and for ordinary disinfectant purposes.

A fierce light now beats upon all forms of municipal industry, and when that form of enterprise is associated with the Metropolitan Borough of Poplar, the interest which it may be expected to arouse is likely to be keen indeed. It is no cause for surprise, therefore, that the description which Mr. Charles Biggs, M.I.E.E., gave of a series of tests he has made on the hermite plant erected by Dr. F. W. Alexander, who is responsible for Poplar's public health, should have called forth some hard knocks on the part of Mr. J. B. C. Kershaw, and other stalwart opponents of misdirected municipal enterprise. The wonder rather is that on this occasion, at least, Poplar should have emerged triumphant with colours flying and critics crushed! But of this more presently.

Hypochlorite solution is produced electrolytically by passing a current through a solution of an alkali chloride, and allowing the products of electrolysis to mix, roughly as represented by the following equations, if sodium chloride be the basis of the reaction—

$$2\ NaCl = Na_2 + Cl$$

$$Na_2 + 2\ H_2O = 2\ NaHO + H_2.$$

Thus, caustic soda and hydrogen are produced at the cathode, and chlorine at the anode. The first and last react as follows:—

$$NaHO + Cl_2 = NaClO + HCl.$$

The hydrochloric acid formed is immediately neutralised—

$$NaHO + HCl = NaCl + H_2O.$$

It is well, however, to add more free caustic soda to the final product, for otherwise the presence of free acid, either hydrochloric or hypochlorus, will tend to make the hypochlorite solution unstable. The addition of caustic soda is one of the essential features of the process as worked at Poplar. The active material of the Poplar solution, however, is not sodium but magnesium hypochlorite, Ma $(Cl\ O)_2$, the latter having superior sterilising properties. The solution used, a kind of artificial sea water, contains a mixture of the two chlorides, but the sodium chloride acts merely as a vehicle for the current, the metallic ion liberated being that of magnesium.

The system adopted is to mix a certain quantity of the fluid in an elevated tank of 215 gallons capacity, and then to allow this fluid to flow through four double troughs or cells, placed one above the other so that the liquid descends continuously by gravity. Each trough is divided laterally by a partition, and in each of the two divisions five distinct "elements" are suspended. The positive plates are of thin platinum wire wound upon slate slabs and the negative plates are of zinc. It was at first objected that the deposition of a close non-conducting film of hydrate would soon render the zinc cathodes useless, but the simple expedient of cleansing them once a day prevents all such trouble. There are thus four troughs each containing 10 "elements," or 40 cells in all. After passing through the successive cells, the liquid discharges into a carboy. The sodium hydroxide used as a preservative as explained above, flows drop by drop into the carboy as it is filling, and then rubber flappers serve thoroughly to mix the fluid—a most important requirement to ensure stability. As the liquid passes through the troughs it is subjected to the action of a current of 15 amperes at 230 volts, being 5·6 volts per cell.

The rate of flow of liquid through the cells is 3¾ pints a minute, so that during a normal run of eight hours some 185 gallons of disinfectant are produced, containing 4 grammes of available chlorine per litre. This is an unusually high concentration, and, as pointed out by Dr. Hutton, accounts for the relatively low-current efficiency urged by Mr. Kershaw against the plant.

As a matter of fact, in a plant of this kind, efficiency is of secondary importance. With electricity at 1½d. a unit, which Dr. Alexander stated to be the cost at Poplar, the energy cost per gallon is only 0·22d., while the total cost, including material, labour and interest, is about ¾d. a gallon—a cost that could be considerably reduced if the plant were made an adjunct to the generating station, where it would slightly help the borough engineer in his quest for a high load factor. In comparing this cost with that of bleaching powder—which in reality is an absurd thing to do, seeing that for public purposes the fluid in many cases replaces carbolic—the convenience of making the hypochlorite on the spot, as required, and the ease with which it can be transported and distributed is a far more important practical consideration than that of initial cost. Again, in water for laying noxious dust—in these days of motor-cars—hypochlorite is an invaluable ingredient, as pointed out by Dr. Rideal, on account of its germicidal properties. These facts have been ignored by the critics of the Poplar installation.

The special tests made by Mr. Biggs on the plant at Poplar were chiefly concerned with the efficiency of the process, which was found to be greatest for a particular current value (16 amperes), and the

stability of the product. In the original Hermite process, as applied to the sterilisation of sewage effluent, of course stability is an unimportant condition, as the hypochlorite fluid is used as prepared. But where the fluid has to be bottled and distributed, and possibly kept for considerable periods before being used, stability becomes almost a determining factor. As is well known, there is a certain limiting temperature below which it is essential to keep an hypochlorite cell, for otherwise oxidation to chlorate takes place. But it was found that the Poplar plant ran quite well during the summer of 1906 at a temperature of 104° F., the liquid losing only 0·1 gramme of available chlorine in six weeks, and that, therefore, it can be made and transported to a warm climate without very rapid deterioration.

Non-stability in the past has been largely due to the presence in the fluid of undecomposed salt. Working under carefully-determined conditions eliminates such salt, and Dr. Alexander claimed that the Poplar plant fulfilled these conditions. The general conclusion to be drawn from Mr. Bigge's experiments is that the magnesium hypochlorite made in the Hermite cell, as at Poplar, is sufficiently stable for all practical purposes.

Mr. W. Pollard Digby, as the title of his paper implies, "Some Investigations Relative to the Depreciation of Electrolytically-produced Solutions of Sodium Hypochlorite," also dealt with the important question of stability, particularly with regard to the practical conditions under which the fluid is stored and conveyed from place to place. It is known that hypochlorite is decomposed by sunlight; Mr. Digby, therefore, experimented on the deterioration caused by various colours of glass bottles, and concluded that dark amber bottles, in which the loss of available chlorine for a 4·2 grm. solution was about 40 per cent. in five years, could be safely recommended for use under all ordinary conditions. Similar experiments on the corrosive effect of various metals were made, and as this was found to be quite appreciable, and as the corrosion is proportional to the area of metal exposed, its use must be avoided or carefully watched. Graphite was apparently without action on the solution. The corrosive effect of metal couples, which has also a practical bearing, was likewise tried, and, as might be expected, greater depreciation took place, particularly when iron was one of the metals, than in the case of either metal singly. Mr. Digby has also tried to see whether insulating materials, such as "bitumastic" paints, cannot be used for painting the inside of metal containing vessels, but he finally deprecated relying on any such protection, as it can rarely be properly applied. He was not even able to recommend the use of bitumenised wood as a substitute for slate electrolysing tanks or for ebonite in electrode construction, as the coating cannot be relied upon to remain intact excepting, perhaps, for temporary purposes.

Finally, in order to reduce the testing of these solutions to a science, the author suggested the adoption of some standard of stability, and he recommended the use of a galvanic couple test which he has devised for the determination of the "coefficient of stability" of any given solution.

In conclusion, Mr. Digby insisted on the importance of small and apparently trivial details when dealing with the manufacture and use of electrolytic hypochlorite solutions on a practical scale. This warning is wholly relevant, for it is only by attention to such details that the use of hypochlorite in spite of much criticism and many gloomy prognostications, has been enabled in the past few years to make real headway, whether for sterilising sewage, as many important plants on the Continent and the plants at Maidenhead and Guildford now show, or whether for the smaller but none the less valuable purpose of supplying an efficient and handy disinfectant to the authorities responsible for public health, as is proved by the success of Dr. Alexander's little Hermite plant at Poplar.

Dr. Alexander Cumming's Paper "On the Electro-chemistry of Lead" will be taken in conjunction with another Paper by the same author, "Contributions to the Study of Strong Electrolytes," at the December meeting of the Society.

High-Speed Electric Machinery: With Special Reference to Steam Turbine Machines.

By Prof. Silvanus P. Thompson, D.Sc., F.R.S.

(Abstract of Howard Lectures delivered before the Society of Arts, *January 18th and 25th, and February 1st, 1906, and published in the Journal of the Society.)*

(*Continued from page* 780.)

Turbo-Alternators.

The effect of the introduction of very high speeds upon the design and construction of alternators may be said to depend upon three extremely simple rules. The first is—

$$p = \frac{120 \times f}{\text{R.P.M.}}, \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where p is the number of poles, and f the frequency or number of cycles per second. The number of poles is then dependent only upon the frequency that is prescribed for the system, and on the number of revolutions per minute of the machines.

The second rule is—

$$\tau = \frac{v}{10 \times f}, \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

where the surface speed, v, is expressed in feet per minute; f, the frequency, by the number of cycles per second; and τ is the pole-pitch in inches.

The third is the well-known rule relating to centrifugal force—

$$F = 0{\cdot}0000284 \times R \times (\text{R.P.M.})^2 \quad \ldots \quad \ldots \quad (3)$$

Here F is the centrifugal force, in pounds' weight, and R is the radius in inches. This formula gives, in pounds' weight, the force with which a pound of material at that particular radius, and running round at that particular speed, tends to fly out. It may be enormous in certain cases.

High Speed and Number of Poles.

Coming back to the first of these rules, I have deduced from it a useful Table.

Frequency (cycles per second).	Revolutions per minute.		
	Two poles.	Four poles.	Six poles.
100	6,000	3,000	2,000
60	3,600	1,800	1,200
50	3,000	1,500	1,000
45	2,700	1,350	900
42	2,520	1,260	840
40	2,400	1,200	800
33⅓	2,000	1,000	667
30	1,800	900	600
25	1,500	750	500
20	1,200	600	400
16	960	480	320

Suppose we require to design a turbo-alternator of 1,000 kw. to work on a system where the frequency is 45; we have then three alternatives before us. We may design a two-pole machine, which must run at 2,700 revolutions; or a four-pole machine which must run at 1,350 revolutions; or a six-pole machine running at 900 revolutions.

High-Speed and Size of Poles.

Seeing that these things hang together, we have to notice how the rest of the design and construction of the machine will follow. Comparing the high-speed machines with the low-speed machines, there will always be a small number of poles, and these will always have a wider pole-pitch because the surface speed is greater. If, instead of having 5,000 ft. per min. for the surface speed, we have 15,000 ft. per min., then the pole-pitch necessarily becomes at once three times as great. Instead of having, therefore, a magnet-wheel of large diameter and small axial length, it will have one that is much smaller in diameter, relatively much longer, like a garden roller in style, and with fewer poles. The poles will be larger, and will have a larger pitch; and they will carry, as a general rule, a much larger magnetic flux.

Take two examples which I have here. Here is a design by the Oerlikon Co., of a machine designed for 1,500 kilovolt-amperes, having 72 poles, and going at a speed of 83 R.P.M. Compare that

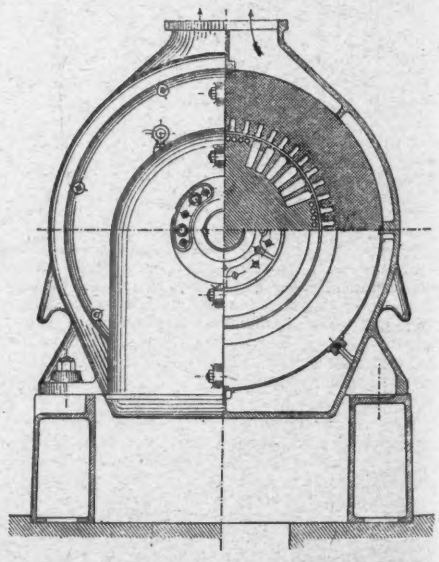


Fig. 11.—Turbo-Alternator with Four Poles, Part Transverse Section. (Brown, Boveri & Co.)

machine with the design (figs. 11 and 12), by Brown, Boveri and Co., of a steam turbine alternator of 1,000 kw., to run at 1,500 R.P.M., and having four poles. The pole-pitch measured at the armature face is no less than 26·2 in. The pole-pitch in the Oerlikon machine is 10 in. The diameter of the revolving part of that machine is nearly 20 ft., and the thickness of the machine from front to back only 9 in. The turbo-alternator, which is of nearly equal power, has a diameter of 33·4 in., and a length from front to back of 25½ in. The poles being longer, and having a greater pole-pitch, occupying on the average about 0·63 of the pole-pitch, it

follows that the actual flux will be greater. In the old-fashioned kind of alternator, one seldom had more than four million or five million magnetic lines coming up through a pole. Modern high-speed alternators have much more. A machine of the fly-wheel pattern could not well be made much more than 12 in. thick from

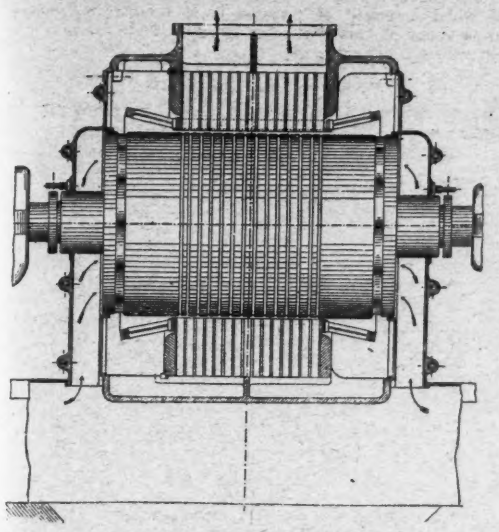


Fig. 12.—Turbo-Alternator, Longitudinal Section. (Brown, Boveri & Co.)

front to back, and it could not, for ordinary frequencies, have a pole-pitch of much more than 10 in., and therefore a pole-span of more than 6 in., so that 72 sq. in. is about the amount of pole surface that you would have. Then 72 sq. in. at, say,

Table of Centrifugal Forces (in pounds per pound of material).

Radius in inches.	Revolutions per minute.				
	750	1,000	1,500	2,000	3,000
10	160	284	640	1,136	2,560
12	192	341	767	1,364	3,070
14	224	398	894	1,590	3,580
16	255	454	1,022	1,815	4,090
18	287	511	1,150	2,045	4,600
20	319	568	1,280	2,272	5,120
22	351	625	1,406	2,500	5,620
24	383	682	1,533	2,730	6,130
26	415	738	1,660	2,950	6,640
28	448	796	1,790	3,180	7,160
30	479	852	1,920	3,408	7,670
32	511	909	2,045	3,635	8,180
34	543	966	2,170	3,865	8,690
36	575	1,023	2,300	4,090	9,200
38	607	1,079	2,430	4,320	9,710
40	638	1,136	2,560	4,544	10,240

50,000 lines per sq. in., gives as the flux 3·6 millions of lines. But when you have a pole surface which, whether it is cut up or not, may be somewhere more nearly 20 in. in span along the periphery, and 25 in. or 30 in., or even more, from front to back, naturally there will be a much larger area of pole surface, and at the same flux density there will obviously be a larger flux. Instead of thinking of four or five million lines, we have to think of 20 million or 30 million lines as the flux from one pole.

High-speed and Centrifugal Forces.

With regard to the effects of high revolutions upon centrifugal force, the above table has been compiled, giving the results of formula No. 3, worked out for a number of cases. Naturally, when we have to deal with such enormous centrifugal forces, which may go up even to 3 or 4 tons per lb., we have to employ structures in which every precaution has been taken to allow a sufficient margin of safety, the materials being of the very greatest strength and tenacity, free from all internal defects; and the pieces that go to make the revolving part, the iron, the copper, the insulation and the hub, which holds the whole thing together, must be so contrived that you have the most perfect balance, in the engineering sense, of the parts; balanced not simply for statical forces and couples, but balanced dynamically, so that when running at a speed even higher than the normal, no harm shall occur by any resonance between the natural period of vibration of the revolving mass on its shaft and its bearings and the frequency of its revolution. And, further than this, the balancing of the revolving part must not only be perfect for the present, but it must be perfect for the future. It was soon found when machines of this kind began to be built that although you might balance a machine as it stood, if the greatest precautions were not taken, six weeks later they might be out of balance. In these constructions, where the stationary part and revolving part are subjected day by day to violent changes of temperature, they heat up and cool down; the materials expand and contract, and if as the result of expanding and contracting they can creep, then there will be loss of balancing. That must be absolutely prevented, and the necessity of utmost solidity has a most marked effect upon the construction of the revolving parts.

Critical Speed.

One of the most serious things that can happen to high-speed machinery is the occurrence of synchronism between the speed and the period of lateral vibration of the revolving mass between its bearings. Every shaft will bend slightly under the weight it carries. Supposing the shaft deflexion, expressed in fractions of an inch, be called D; then the speed that is critical may be reckoned in revolutions per minute by the rough-and-ready rule—

$$\text{Critical speed} = 200 \times \sqrt{1 \div D}.$$

Thus, for example, if a machine had a deflection of $\frac{1}{500}$ of an inch, the critical speed at which the shaft would whip would be about 6,000 R.P.M. Now it may happen that in consequence of a sudden rupture of the circuit the load may be suddenly taken off a machine, and, unless the governor acts very promptly, that machine will begin to race. It is, therefore, of utmost importance that the shaft should be very stiff, so that the dangerous critical speed may be far above the normal speed of the machine.

High Surface-speed and Specific Duty.

The next thing to point out in the influence of these high speeds, is that because the surface speed is high you are able, as was shown in the first lecture, to get a higher specific duty out of the cubic inches of iron and copper in the active belt. But if we are making our cubic inch do more duty, and have a relatively less number of square inches of surface from which to get rid of the heat, there is danger of the temperature rising too high. If, therefore, we would keep our machine cool, we have artificially to ventilate it in some way. We must increase artificially the number of available square inches of surface, and not trust to the high speed for ventilation, but force the ventilation in some way or other by providing special means for that purpose.

Effect on Design of Stator.

The fact that the pole-pitch is wide introduces two further difficulties of construction, one relating to the winding, and the other relating to the iron of the stator. If the pole-pitch is wide, so that we have to wind in the slots of the stator coils which arch over a distance of 20 or 30 in., it is clear that the end-bends will be relatively large; they will stand out more from the machine, and they will be subjected to considerable forces. It is, therefore, imperative that the end bends be anchored by special supports to the housing, and they should be designed with this view, to guard them against mishap from the mechanical forces that come upon them in the event of a short circuit.

Then, again, on account of the need of making the voltage drop small, the air-gaps between the revolving part and the stationary part have to be a great deal wider than was the practice in the old machines. With those wider gaps, and the larger amount of magnetic dispersion at the ends, the forces on the end-bends increase. And further, because the gap is wide, there will be a revolving stray magnetic field which can set up eddy currents in the metal shields or casings that protect the end-bends of the winding. This is a new kind of danger never realised before the introduction of these steam turbine machines.

Then, as far as the iron of the stator is concerned, there is a new point. The poles are wide apart, and the magnetic lines going through the iron of the stator core from pole to pole, have to pass along a considerable arc spanning over an angle, not of some 5°, as they would do in a 72-pole machine, but (in a four-pole machine) going over 90° or nearly so. It follows that the difference in length of path for the shortest lines and for those which have a maximum path from pole to pole will be very much more marked. With this highly curved antipolar surface there is a greater tendency, therefore, for the magnetic lines to crowd up immediately behind the roots of the stator teeth, and for that reason a greater depth must be left behind the roots of the teeth, lest there should be too great a hysteresis loss in consequence of too high a saturation in that part.

Solidity of Rotor.

There is yet one other conclusion which would never have been suspected beforehand. Because of the absolute necessity of designing the revolving parts so that the windings shall not shift, in order that the future balance of parts shall be maintained you cannot have fine wire winding on the revolving field magnet I was going to say that you cannot have any wire windings at all you call them windings, you must do so in some modified sense. The windings must be so highly mechanical that they will consist of stout strips of copper, so anchored and so embedded that they cannot possibly shift. They must, therefore, carry a large current, the energy must be given to them at a low voltage, and the insulation upon them may then be reduced to a minimum. Instead of exciting at 200 or 500 volts, as was quite common in slow-speed alternators, we go down to 50 volts, and 20 volts, and 10 volts. In Lecture II there was mentioned an exciter for a British Westinghouse alternator which works at 10 volts. I shall not be at all surprised if we have the exciters, and, therefore the field-magnets of future turbo-alternators designed to work down to 5 volts,

You gain in mechanical solidity, and in the thickness of the insulation.

Output Formulæ.

Let us now revert to the fundamental formulæ of output of alternators which were give in Lecture I. These are

$$d \times l = \beta \times \text{K.V.A.};$$

and

$$\beta = \frac{15{\cdot}9 \times 10^{10}}{k \times B_g \times q \times \psi \times v}.$$

The factor, k, which appears in the denominator, has values from 1·11 to 1·06, according to the form factor of the distribution of the magnetic flux and the concentration of the windings. If the magnetic flux is distributed as a sine function in space, and the winding is concentrated in single slots, the value 1·11 is appropriate; but if the winding is distributed over 2, 3 or 4 slots per phase, the value goes down to 1·08, 1·07 or 1·06. For low-speed alternators, the pole-faces were usually concentric with the stator bore, but often bevelled off at the corners, giving a fringe of diminishing intensity. But in high-speed alternators great attention is given to the shaping of the poles to bring about an approximate sine-distribution of the flux. Hence it is difficult to assign particular values to ψ the ratio of pole-span to pole-pitch. If a sine-distribution is attained, then the ratio of the average value of the field to its maximum is the mean value of the sines of all angles between 0° and 90°, namely, 0·634. In other words, if B_g represent the flux-density at its maximum, where the gap is narrowest, then the average flux-density is $B_g \times \psi$, where ψ is the ratio of mean to maximum. In practice, ψ varies from 0·6 to 0·7; but it is usually near 0·63. One reason why it is important to shape the pole-faces to secure a sine-variation, is the necessity of keeping down the hysteresis losses at low loads. The process of design by the use of the $d \times l$ formula, using the Steinmetz coefficient β, is appropriate for alternators, while the use of the $d^2 \times l$ formula, using the Esson coefficient ξ, is appropriate for continuous-current dynamos, because in the former case peripheral speed is a dominant factor in the design, whilst, in the latter case, the dominant question is good commutation, and peripheral speed is of but secondary importance. Since then we can, in the case of alternators, fix beforehand, from the result of experience, all the factors, k, B_g, q, ψ, and v, the calculation of the Steinmetz coefficient, and consequently of the leading dimensions, d and l, becomes a rational process.

Suppose, for example, we have to design a turbo-alternator of three-phase pattern, working at 5,000 volts between lines (*i.e.*, 2,886 volts in each phase), and giving three currents of 475 amperes each, at 40 cycles per second. Then $3 \times 2{,}886 \times 475 \div 1{,}000 = 4{,}120$ K.V.A. By the table of frequencies given above (page 818) the frequency of 40 limits us to one of the following speeds:—2,400 R.P.M., 1,200 R.P.M., and 800 R.P.M.—according as the revolving field-magnet is designed with 2, 4, or 6 poles. The turbine maker would probably not wish to construct a 5,000-H.P. turbine at 2,400 R.P.M., but would prefer one at 1,200 R.P.M.; so that this involves a 4-pole design. Now if, as the result of experience, we adopt the following values:—$k = 1{\cdot}08$, $B_g = 42{,}000$, $q = 667$, $\psi = 0{\cdot}63$, $v = 13{,}600$; inserting these in the formula will give as the Steinmetz coefficient $\beta = 0{\cdot}64$. This gives $d \times l = 2{,}513$. If v is not to exceed 13,600 ft. per min., then d cannot exceed 43·3 in. If d is taken at 43 in. then l will be 38·8 in., and the pole-pitch will be 33·75 in.

Consideration of these design formulæ will bring out several points. In the older fly-wheel type of alternator, with a foundation wheel of cast-iron, it was not safe to use a peripheral speed of more than 5,000 ft. per min. If, then, as the further result of experience it was found that the gap-density could not well be more than 40,000 lines per sq. in. without making the no-load losses too great, and that the specific loading q could not be made more than 650 amperes per inch without causing the voltage drop at full load to be too great, it would follow that in such machines the coefficient β could not well be reduced below 2 or 2·5. But if by adopting the special rotor construction appropriate for turbine work, and the consequent use of steel structures, surface-speeds of 15,000 ft. per min. can be safely attained, it follows that, other things being equal, the coefficient β will come down to one-third of its former value, that is, one can construct machines having but one-third of the amount of polar surface for an equal output. If we turn to the facts, we find that for eight recent turbo-alternators, the values of the output coefficients run as follows:—0·65, 0·76, 1·18, 0·74, 0·72, 0·86, 1·17 and 1·4. These figures indicate a very important reduction in the material needed in construction.

Some Contrasts in Design.

By way of contrast, consider the largest machines of the older type that have been built. These are the eight machines furnished by the Westinghouse Co., of Pittsburg, to the Manhattan Station in New York. They are three-phase machines of 5,000 KW. each, having 40 poles and making 75 R.P.M. The diameter of the rotating magnet wheel is no less than 336 in.—28 ft.—while the axial length of the pole-core is 22 in., so that $d \times l = 7{,}392$, and β is therefore 1·48. The peripheral speed, even though the whole revolving structure is built up of steel, is only 6,710 ft. per min. These Manhattan machines are most imposing, with their huge vertical engines of marine type. But there will be no more built. Compare one of these sets with a modern Westinghouse turbine set, of equal output, and the comparison at once shows the great saving, not simply in steel and copper, but in floor space and foundations. Revolving at 1,000 R.P.M., and with a diameter of 67 in., the peripheral speed attained is over 17,600 ft. per minute, and the coefficient β comes down to 0·65.

As in many other departments of electrical machinery, so here, the design will be modified according as the requirement is for a machine that is to work on a continuous full load, or on a variable load in which for a large percentage of the time the output is small; for in the latter case the iron losses (which are nearly constant at all loads) must be kept low, whilst in the former case they may be relatively high—equal, in fact, to the full-load copper losses. Hence, in machines coming under the former case it is permissible to use higher flux densities, and therefore also the specific electric loading may be higher, as with the higher magnetic densities there is less voltage drop due to distortion. Of course, there will be more heat generated, and adequate ventilation must be provided; but, assuming this to be done, if the machine is designed for higher values of B_g and q, the value of coefficient β will be correspondingly reduced; that is, the size of machine will be smaller in proportion to its output.

(To be continued.)

Institution of Electrical Engineers.

Birmingham Local Section.

On Wednesday last, Mr. R. A. Chattock, Chairman of the Section, delivered his inaugural address. After thanking the members for the honour conferred upon him, he congratulated the Local Section upon the large number of gentlemen connected with the educational side of electrical engineering, and holding some of the highest positions in the educational world, who were included amongst its members, and being thoroughly conversant with all branches of the industry, were able to give the Section the benefit of their all-round knowledge. He regretted that the younger members did not take part in the discussions, and urged them to do so.

Mr. Chattock then turned to the considerations governing the development of electricity supply in Birmingham, and pointed out that by delaying it until the present, the city had been able to adopt the most modern apparatus and methods in readiness for dealing with the enormous power demand that was anticipated. Some of the large manufacturers were considering the installation of motors of hundreds of horse-power—from two or three even to fifteen hundred. The tramways would ensure an immediate return upon a large portion of the capital outlay, but the power demand would be much larger, and would have a very much better load factor. By charging a low price to consumers whose load factor was good, an enormous business could be built up.

But the question of lighting supply was not to be ignored; the high efficiency of tantalum and Nernst lamps was popularising electric light, and their use would considerably stimulate the business of the supply authority. The Cooper-Hewitt, or mercury vapour lamp, also was coming to the fore in connection with factories and workshops, many of which were being fitted up with this type of lamp. The results gave the highest satisfaction as regards both the quality of the light and the economy of energy.

Regarding the system of supply, the existing stations were retained to deal with peak loads only, the direct current being supplied to them in bulk from the new station for the all-day load; this was more economical than to supply alternating current and convert it to direct.

For the outlying districts, however, where no supply had previously been given, while the system of supply was the same as in the central districts (three-wire, 440 volts), high-pressure transmission was necessary, the five distributing centres being about 3 miles from the power station. Three-phase current at 5,000 volts, 25 cycles per second, is employed, with transformers and rotary converters. Thus direct current is available all over the city. But for large manufacturers, whose loads would interfere with the pressure regulation, it was intended to lay a ring main completely round the city, from which the large works would be supplied at high pressure, with three-phase current. The direct-current supply to the tramways is given from the generating station up to a distance of 2 miles; beyond that radius it is derived from special rotary converters in the sub-stations. The feeder cables were linked up in such a way that a through supply could be given on emergency.

LEGAL.

City of London Electric Lighting Co. *v.* Melling.

In the City of London Court on 15th inst., before his Honour Judge Lumley Smith, K.C., an action was brought by the City of London Electric Lighting Co., Ltd., Great Winchester Street, E.C., against Mr. James Melling, engineer, Dashwood House, New Broad Street, E.C., to recover £2 19s. 9d. for electric energy supplied. The defence was that the plaintiffs' meters were inaccurate.

Mr. Page, for the plaintiff company, said they had supplied the defendant with electric current for some time, and recently it was discovered that the meter which the company had supplied him with was registering current against him when, in fact, he was not using the electric light. The defendant objected to pay the last account, as he said he was only using half the radiators formerly alight, and the company had charged him four times more than usual at that period of the year. The plaintiff company's Act of Parliament provided that where a dispute arose as to the accuracy of a meter it was to be tested by the local electrical official. The City corporation's electrical engineer, Mr. A. A. Voysey, had made a test, and then it was found that the meter was all wrong. The

company then made their present claim, but the defendant still refused to pay.

Mr. Voysey told the Court that the meter went 2·8 per cent. faster than the correct rate.

Mr. Cassie, defendant's solicitor, said defendant's grievance was that the meter was not only faster, but it would have gone on for ever, although no lamp was being burned.

Mr. Page pointed out that in the absence of fraud, which was not raised, the defendant was bound by the state of the meter and the certificate of Mr. Voysey.

The Defendant said he only used the electric light for radiators.

Mr. Voysey said he did not think much care was taken with regard to the consumption of lamps put into radiators. They were not subject to very great supervision. It was possible defendant's radiator might have been out of order.

Judge Lumley Smith said he was sorry for the defendant who, he could quite understand, felt very much annoyed, but he was bound by the meter, according to the contract to supply.

The Defendant: Supposing they charge me 1,000 units more than I have consumed. Must I pay?

Judge Lumley Smith: Yes, if the meter says so.

Judgment was given for the plaintiff company, with extra costs, the case being one of importance.

Wilson *v.* the Leeds Corporation.

At the Leeds County Court on the 16th inst., before his Honour Judge Greenhow, the Leeds Corporation were summoned for £100 damages for personal injuries caused by the collapsing of an overhead trolley wire, the action being brought by Mrs. Ellen Wilson. Mr. R. A. Shepherd was for the plaintiff, and Mr. J. A. Green for the defence.

Counsel stated that the plaintiff was riding on an electric car from Headingley to Leeds on Sunday, June 24th, when the overhead wire snapped and fell on her, and she was rendered unconscious. She was attended by Dr. Rumboll for concussion of the brain, and her sight, hearing and memory were affected. For six weeks she was entirely incapacitated.

Prof. J. O. Arnold, of Sheffield, had made an examination of the fractured wire, and stated that if it had been properly examined within a reasonable time before the accident, a deformation which had been caused by strain, should have been detected. The test showed a reduction of 13 per cent. in the area of the cable.

Mr. Cuttriss, consulting electrical engineer, Leeds, agreed with the foregoing, and said that a reduction in area of 10 per cent. was unsafe.

In defence, counsel submitted that there had been no negligence on the part of the defendants. The overhead wires used in Leeds were thicker than in other towns in the kingdom. The wire had been examined within ten days of the accident. What occurred was a sudden defect, such as could not be foreseen.

The conductor of the car insisted that the wire did not strike the plaintiff at all.

Prof. Goodman, of Leeds, said there was no latent defect in the wire. It was not possible absolutely to safeguard against accident, and he did not think the breaking of a wire of this sort was preventable by any care or skill. We had not yet got an ideal system of suspending the wires, but he did not know a better.

His Honour considered the accident was traceable to the direct negligence of the men who examined that particular wire and passed it as safe, when it was perceptibly not safe. He had not the slightest doubt that the plaintiff was struck on the head by the wire, and she had been seriously injured. On the ground of direct negligence he gave a verdict for the plaintiff, damages £75.

Routledge *v.* Hill and Another.

This case came before Mr. Justice Jelf and a jury in the High Court of Justice on Tuesday last; it was an action brought by the plaintiff, Mr. F. J. Routledge, of 71, Crown Road, East Twickenham, for libel contained in certain letters written to a client of the plaintiff's by the defendant, Mr. A. W. Hill, works manager of the Sir Hiram Maxim Electrical Co., Ltd., which was associated with Mr. Hill in the charge.

Mr. Lewis Thomas appeared for the plaintiff, and Mr. Macoun for the defendant.

After a prolonged hearing, on the suggestion of his Lordship, a settlement was arrived at.

Mr. Macoun stated on behalf of the defendants that he offered a most ample apology for the unfortunate letters, and that it never was the intention of Mr. Hill to write a word reflecting upon the character, integrity or honesty of the plaintiff. The defendants agreed to the withdrawal of the record, and would pay the costs of the plaintiff.

Mr. Thomas pointed out that the action was brought solely to clear the plaintiff's character, and he had no wish to make money out of it, or even to get damages to reimburse the losses which he had sustained.

Mr. Justice Jelf said that it was the most satisfactory termination of the case. The letters might have imputed something very serious to the plaintiff, though he was sure that the defendants had no such intention. The defendant had taken the proper course; the plaintiff left the Court absolutely clear from the slightest blame upon his character or his way of doing business, and he hoped the plaintiff would succeed in future.

Thefts of Electrical Apparatus.

Leslie H. Freeman, an architect, was, on the 16th inst., charged at Newington with stealing 7 cwt. of electric cable, the property of the Western Electric Co., Ltd. It was stated that the cable was stolen from prosecutors' premises, which adjoined those of prisoner and his brother, who carried on business as vinegar merchants. A previous conviction was proved, and the prisoner was sentenced to nine months' hard labour.

At the Tower Bridge Police Court, on the 16th inst., Thomas Keating, Robert Waller and John Charles, were remanded on a charge of stealing a quantity of electrical material, value £10 10s., the property of Keating's employers, Messrs. Hampton & Sons, Ltd. Pall Mall East.

Mischievous Interference with an Electric Line.

On Monday, at the Police Court at Penkridge, near Wolverhampton, John Lunn, motor driver, Stafford Road, Cannock, was charged with contravening one of the special rules for the installation and use of electricity, by interfering with an electric line at the Littleton Colliery, at Huntingdon.

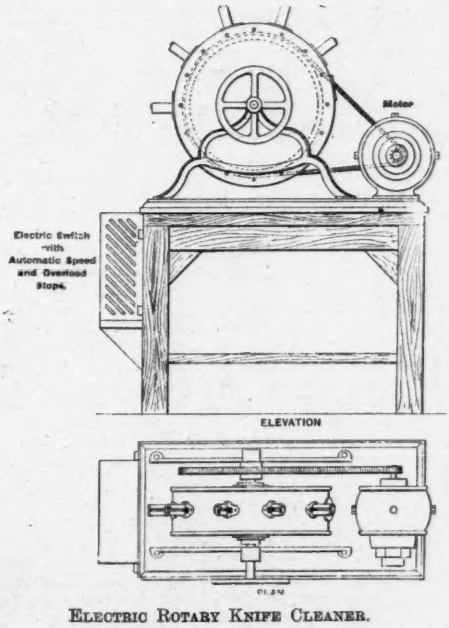
Mr. Daniel Rogers, manager of the colliery, stated that on the 5th inst. the defendant connected a power cable to a signal wire and passed an electric current through to the signalman, who was injured, and might have been killed. The pressure was 500 volts. When witness saw the defendant he remarked that he had a grudge against the signalman. The latter stated that he signalled to the defendant to start the motor, but as it did not move he was about to ring again when the wire caught his arm and doubled him up.

The magistrates imposed a fine of 40s. and costs, telling the defendant at the same time that his offence was both serious and outrageous. The defendant, it may be stated, is only 14 years of age.

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

Electric Rotary Knife Cleaner.

The accompanying illustration shows how Messrs. George Kent, of 199, High Holborn, W.C., have adapted electric driving to their well-known knife-cleaning machine. The motor, of a size depending upon the size of the machine, is fixed with the latter upon a stout



Electric Rotary Knife Cleaner.

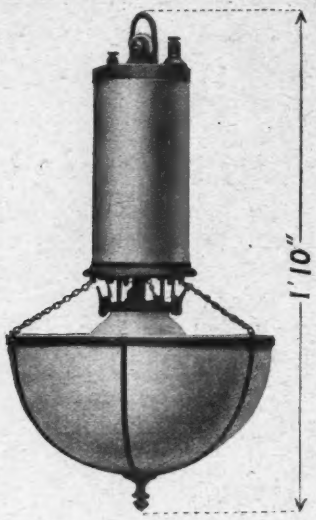
stand, and drives the machine by a chain and sprocket wheel. The special feature of the device, however, not shown in the illustration, is the automatic time stop. The effect of putting in the knives, starting the machine, and forgetting all about it, is to polish the knives up nearly to red heat, to wear both knives and machine, and to use up energy unnecessarily. To obviate these inconveniences, Messrs. Kent provide, in addition to the usual starting rheostat with overload and no-load release, a patent adjustable cut-off, which automatically stops the machine after any set interval of time. Thus, after the knives have been put in and the machine started, it is left to itself until it stops, and thus indicates that the knives are properly polished. It appears that Messrs. Kent & Co., some of whose original machines have been in constant use for upwards of half a century, make a point of endeavouring to over-

come difficulties reported to them by their customers, and it is in this way that the need of a cut-off device was discovered, and quickly satisfied. It seems probable that a similar cut-off might be usefully applied to a good many other electrically-driven apparatus.

Small Arc Lamp.

The Westminster Engineering Co., Ltd., of Victoria Road, Willesden Junction, N.W., are making a small arc lamp with a special opalescent bowl fitting, as shown in the accompanying illustration.

The lamp is specially made for drapers' establishments, or any business that requires a soft but pure white light, showing colours in their true shades, this lamp being admirably adapted for the

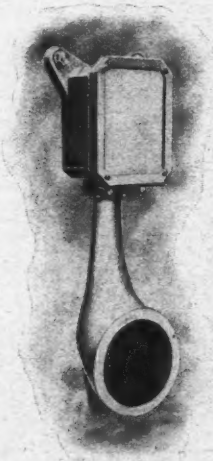


Small Arc Lamp with Opalescent Bowl Fitting.

purpose. The inner globe is of clear glass. Of course if there is a white ceiling a good deal of reflected light is usefully employed. The lamps are made for a current of three to four amperes, and for burning singly on 100 volts, and two or more in series on correspondingly higher voltages.

An Electrical Siren.

A new signalling apparatus is being introduced by the Deutsche Telephonwerke, Berlin, for mines, railways, ships, &c., in the shape of a patent electric siren. This is made in two patterns, for indoor and outdoor use respectively; the accompanying figure shows the gas and water-tight outdoor pattern (model B). The device is suitable for all voltages, and gives a very loud penetrating and far-reaching sound, with a small consumption of current. The



Electric Siren.

sounds being sharply marked off at start and finish, can be used for Morse signalling. At 10 or 12 volts the current consumed is about $\frac{1}{10}$ ampere. The mechanism, we are told, depends for its operation on "the alternating action of the armature of an electric magnet of a given number of vibrations on a metallic diaphragm by aid of an elastic double-armed lever with unequal arms, the ratio of which is accurately determined for obtaining a clear and powerful note." The explanation might be more lucid. The diaphragm is of bronze, and hermetically closes the apparatus. Messrs. Plutte, Scheele & Co., of 18 and 19, Queenhithe, London, E.C., are sole agents for this country and the Colonies.

CORRESPONDENCE.

Letters received by us after 5 p.m. on Tuesday cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

The Otto Electrical Manufacturing Co., Ltd.

With reference to the paragraph in your issue of the 9th inst., as follows:—

Otto Electrical Manufacturing Co. (1905), Ltd. A meeting of this company is to be held at 14, George Street, Mansion House, E.C., on December 5th, to hear an account of the winding up from the liquidator, Mr. E. H. Fletcher.

Please allow us to state that the meeting referred to is a meeting of a company formed in 1905 but now in liquidation, and in no way connected with the above company formed in 1904, which is still carrying on business at 504, Stockport Road, Manchester.

Edward Heath & Sons,
Solicitors for the Otto Electrical Manufacturing Co., Ltd.

Manchester, *November* 15th, 1906.

Advertising in Electricity Works Pamphlets.

The manager of an electrical manufacturer's publicity department is generally limited to a certain annual expenditure for advertising purposes. In these days of small profits he finds it exceedingly difficult to distribute his restricted appropriation in an efficient manner amongst the many technical journals, old and new, which he may consider good advertising media. His difficulties have not been lessened by the recent appearance of several "hybrids," which are printed in bulk and sold to supply undertakings for distribution to their consumers—useless as these journals are.

However, certain station engineers are apparently not satisfied with these journals, which are edited by expert publicists; they think they can produce something better themselves, and we have recently seen some remarkable examples in this direction.

Now, I do not wish to say anything to discourage the efforts of electricity supply undertakings towards publicity; and my object is not so much to criticise the style as to protest against the cadging for advertisements for these publications.

We are informed by the borough electrical engineer of Little Puddleville that he contemplates issuing a pamphlet to his consumers; that this will be an excellent opportunity for bringing our goods before their notice, and—will we take space? We find it difficult to refuse, first, because we must placate the engineer; and, secondly, because if we do not advertise, most of our competitors will. It is a questionable point in commercial ethics whether outsiders should be thus practically forced to guarantee a speculation, the expenses of which ought legitimately to be defrayed by the publishers; for it should be noted that the entire object, and practically the sole direct result, of such publications is to benefit the electricity undertaking. My chief grievance, however, is that each time one of these brilliant literary corruscations appears, we are compelled to reduce the balance of our appropriation (by sometimes as much £5), and money is thus diverted from more useful forms of advertisements. The danger is that the number of consumers' pamphlets is increasing year by year, and the ultimate result will be disastrous, unless some sort of common understanding is arrived at. In my opinion, we should discourage the taking of advertisements at all costs, whilst giving the principle of publicity to consumers our moral and practical sympathy by assisting to provide the letterpress and blocks.

It has occurred to me that this matter might well be discussed at a meeting of managers of publicity departments; in fact, there are many other questions, the discussion of which would be to our mutual benefit. A Society of Managers of Electrical Publicity Departments might be formed to meet, say, once a month to read papers, exchange ideas and take collective action against abuses. At the same time we should all benefit by becoming better acquainted with each other. For many reasons it would be difficult

for any one official to take the initiative in the matter, but if my colleagues respond to this suggestion perhaps the editors of the ELECTRICAL REVIEW would kindly lend their services to bring us together.

Publicity Department Manager.

[We sympathise with our correspondent, and shall have pleasure in affording any assistance in our power towards the movement suggested—provided that a sufficient measure of support is forthcoming. We, therefore, invite readers interested in this matter to write us, either privately or for publication in this column.—EDS. E.R.]

Your contributor on the subject of business extensions for electric lighting stations very properly refers to the value of good canvassing publications; but I regret to see that he gives some encouragement to the multiplication of local pamphlets by stating that the cost of these can be largely met out of advertisements. The practice of touting for advertisements for these publications is becoming very objectionable, as in many cases manufacturers feel that it is necessary to give an order to retain the goodwill of the local management, although the value of the advertisement is very small because these publications are distributed amongst people who are merely possible customers, and probably not one per cent. becomes an early buyer of electrical apparatus. Even if he does, it would suit his purpose better to look through the pages of the ELECTRICAL REVIEW when selecting manufacturers from whom to obtain prices.

There are obviously reasons why the technical Press should refrain from encouraging the increase of these pamphlets and periodicals which seek to make manufacturers pay their expenses, but, of course, much of the interest can be avoided if, as your contributor afterwards suggests, the local managers merely purchase copies of a general canvassing magazine and make the necessary slight adaptation to their own purposes. I should like to see an understanding arrived at by manufacturers, to discourage canvassing by "pressure" for their advertisements for publications of merely local interest.

Publicity Manager.

Penetrating Qualities of the Mercury Arc Light.

I hope to find time next week to reply to Mr. Dow's criticisms of my views on this subject, but in the meantime, I would like just to refer to "Sol's" letter in your current issue, and beg to inform him that I refuse to distinguish between transmitted and reflected light when considering transparent bodies, because I have already pointed out that transparent bodies assume the colour that they best transmit, and therefore they reflect colour that they best transmit, because bodies are only seen by reflected light.

One can take any transparent body and prove the truth of this statement by actual experiment. For instance, a green leaf both reflects and transmits green light most freely; chlorine gas transmits and reflects yellowish green light most freely, and so example on example could be cited until the whole list of transparent bodies were exhausted.

What is true of all other transparent bodies must surely be true of air, and if, as "Sol" and your other correspondents admit, air *reflects* blue light best, then I say that it follows without question that it also *transmits* blue light best.

C. Orme Bastian.

London, N.W., *November 13th*, 1906.

Rail Corrugation.

I have followed with great interest the controversy on the question of rail corrugation, but, so far, have not seen my own theory advanced by anyone else, and noticing the other day a passing tram suddenly develop a tremendous noise, it at once struck me that it was passing over a "roaring rail." On inspecting the rail, I found that there were very plainly marked corrugations on it. I, therefore, closely watched for further occurrences of this, and finding that these seemed to bear out my own idea, thought I would write to you and see what your other contributors have to say to it. My theory is that these rail corrugations are due to "skidding," not, however, as one of your former writers suggested, due to the application of the brakes being just sufficient to alternately lock and release the wheels, but to "the difference in the tread diameters of the two wheels."

Do you not think it possible that, owing to the camber of the road, the wheel nearer the kerbing is at times running on its largest diameter, *i.e.*, with the flange grinding on the inside edge of the rail, whilst the off wheel is running on its smallest diameter (the wheel treads being somewhat tapered)? If this is the case it follows that one wheel must skid a certain amount, every revolution, to make up the difference in the circumferences. This would apply still more forcibly to sharp curves where, I believe, the greatest amount of corrugation has been found to take place. I particularly noticed that by far the greater number of "patches" of these corrugations were on the far rail, from the kerbing, which to me rather strengthens my theory, as, the near rail, being slightly lower than the far rail, the car, whilst running, would tend to slide on to this rail, with the consequence that the near wheel would be forced to run on its largest diameter, at the same time taking a greater weight of the car than the onter wheel, which would be running on its smallest diameter; hence the near wheel would roll its true circumference, whilst the far wheel would be forced to skid to make up the difference of the two circumferences. This alternate skidding and rolling is first started by some uneveness in the rails always throwing one wheel on to its largest diameter at the same spot and ultimately forms the corrugations.

This theory, I should imagine, would also hold for steam railways where corrugations do appear, but as the bull-headed rails, as used on steam railways, are rounded on the head, this tends to keep both wheels on a more equal diameter, and consequently corrugations would not appear to any great extent.

Herbert Rayner.

P.S.—The corrugations to which I refer are very plainly visible on the track of the Liverpool Corporation Tramway, down the Aigburth Road.

Liverpool, *November 14th*, 1906.

As the discussion on "Corrugation" is becoming personal instead of instructive, and as Mr. Percy A. Yapp casts sneers at "Technical Training," and even now does not see the point which Mr. Coxon in his letter was trying to prove, viz.: "That because there were corrugations down hill on the 'regenerative system,' it could not be caused by sparking, being under the impression that 'the regenerative system did not require a *return* circuit,'" I think Mr. Yapp would have been better employed in reading more carefully the letters, than in sneering at technical training—as any engineer in our day considers that a practical training is no use without a sound theoretical one also.

I do not remember when I was Senior Demonstrator whether Mr. Yapp was one of my "students" or not? But, if so, I am sorry he did not profit more by the training.

However, I can inform Mr. Yapp that I am in no way ashamed of having held the position of Senior Demonstrator; on the contrary, I am proud of the fact that my theoretical training was considered sufficient for the London County Council to appoint me.

For Mr. Yapp's benefit, I may also inform him that probably before he ever entered the electrical engineering profession, I had had experience with tramways, and with one large firm, as chief assistant engineer and manager, I was responsible for one of the earliest electric tramways in the country.

Surely, Mr. Coxon is quite able to take care of himself, and does not want the support of the gentleman in question.

One question may I ask your readers—viz., "Do they for one instant mean to suggest that sparking between the rails and the tramcar wheels does *no* damage to the surface of the rails?"

I have been very much interested in Mr. Harvey's letter, and I have had the opportunity since of inspecting not only tramway rails, but also angle iron and various bar iron (all of which has been subjected to the rolling process), and have been surprised to find that regular corrugations or "flat-

nesses" exist in these; there is no doubt that these "flatnesses" must be caused during the rolling, and then comes in my suggestion—viz., that as the car wheel runs over these different surfaces it sets up sparking, which sparking eats away the hard skin of the metal surface, and it does not take very long before serious corrugations result.

Horace Boot,
Consulting Engineer and General Manager.

Tunbridge Wells Electricity Works,
November 19th, 1906.

Mr. Boot asks me to which section of the L.C.C. Tramways I refer, and where the corrugation can be seen.

The Tooting section has especially come under my notice, and if Mr. Boot ever travels over it, he cannot fail to notice that the trouble is quite common practically over the whole line. If he wants to have exact spots pointed out to him, I would say that corrugation is very marked on the down line, a few yards before arriving opposite Messrs. Causton's printing works, situate between Kennington Church and Stockwell. The same also occurs 100 yards further down the line, on a perfectly straight stretch.

I first noticed corrugation on these lines about 18 months ago, near the Kennington Theatre.

I have measured some of them, and find that the pitch is usually 2½ in., although I have come across stretches with a pitch of 2 in. only.

In each individual case, the pitch is perfectly regular.

"Interested," who, I see, wrote on the same date as myself, has evidently also noticed corrugation on conduit tramways.

I quite agree with you, Mr. Editor, in your opinion on Mr. Harvey's observations. I think this is certainly the most probable and most scientific reason as yet put forward as to the cause of rail corrugation. This theory quite explains the regularity of the pitch, whilst the other theories which have been advanced fail in this respect, as there is no real reason why such effects as the hammering of toothed gears, transmitted through the wheels, or the vibrations set up in the rail should always be made evident at the same spots on the tread, by successive cars. In the former case, the pitch will always be the same, and this will also hold good in the latter case, given that the speed of the successive cars is the same, as the frequency of the vibration of a certain rail is invariable. But why should the effect caused by one car be "in phase" (if I may use the expression), with that of the next?

Mr. Harvey's theory, which is based on the fact that corrugation already exists in some form in the rail, is evidently more likely to be correct.

P. Well.

London, S.W., *November 18th*, 1906.

With reference to my letter which appeared in your last issue, it has been brought to my notice that there is some doubt as to the position of the buckling or corrugation which I observed in the web of the rail. What I meant by a "vertical buckle," was such a one that, supposing the head of a rail to be removed, an observer looking down upon the rail as it lay upon the ground would see the web as a wavy strip having its maxima or minima 2½ in. apart.

Upon looking over an article which appeared in a contemporary by Mr. John Hart, of Middlesbrough, although I do not agree with his theory, I see that, incidentally, he supports mine of the cause of buckling in the web, for he says that a rail usually contracts more in the head than the flange, and, therefore, I take it more also than the web.

Again, I suggested that the "2½ in." was, perhaps, a function of the ratio of the area of the sections of the head and of the foot to the area of the section of the web. Upon measuring, roughly, such areas of a section of 96-lb. rail, and taking only the thick portion of the foot which adjoins the bottom of the web, and excluding the thin extremities of the foot, I find that the ratio does approximate to 2½. I excluded the thin extremities of the foot, because it is apparent that these cool off very quickly.

I may say, also, that it is very probable that the buckle in the web causes segregation at every wave, for unequal stresses must be set up at each wave, and would thus cause regular segregation by purely mechanical means, apart altogether from the question of bad mixing of the molten steel.

Lionel E. Harvey.

Sunderland, *November 19th*, 1906.

Patents and Prejudice.

I quite agree with "Statistics," and thank him for his letter. If he will look at my letters again, however, he will see that in both I put it that an extra import is paid for by an extra export. It was to avoid the necessity of an explanation of the effects of foreign capital in England and British capital abroad that I used the word extra.

J. Swinburne.

London, S.W., *November 13th*, 1906.

Glasgow Technical College Scientific Society.

Mr. W. W. Lackie, chief electrical engineer to Glasgow Corporation electricity department, delivered the opening address in above connection, as per your issue of 26th ult.

In contradistinction to the purport of Mr. Lackie's remarks, I should like to say—

1. The cost of production of power does *not* depend on the total motors or lights installed by consumers, nor does it depend on the ratio of the maximum output from the power station to the total horse-power of motors or lights installed.

It *does* depend on the maximum output and on *load factor* of station—

$$\text{L F} = \frac{\text{average load}}{\text{maximum load}}.$$

Because surely the maximum output governs the minimum amount of plant required in the station, while the load factor gives the percentage of use made of this plant.

I shall be glad if Mr. Lackie will give this his attention.

Unit.

The American Additional Article to the Wireless Telegraph Convention.

I note in your issue of November 16th a communicated article on the subject of the Wireless Telegraph Conference, in which the author states that a proposal was "sprung upon the Conference by the American representatives to make ship-to-ship communication compulsory," &c.

As an eye-witness, I beg to state that the American delegation never sprung anything on the Conference. Within one week of the opening of the session, they made a declaration in favour of the fullest possible interpretation of Art. III, which bore on the subject of intercommunication without regard to system. Within two weeks they put in an amendment to one of the articles of the regulations, stating specifically that they wanted communication between ship and ship to be compulsory. The President of the Conference naturally did not wish to consider it, as it was not specifically set down in the protocol; but the American delegation insisted, in season and out of season, whenever there was a public opportunity, from that time on, and pointed out that in this matter we had had more experience than all the other nations together. Finally, towards the end of the fourth week, we got a vote, and the vote showed a very large majority in favour of the American idea.

On a motion of Great Britain, it was then made an additional article to the Convention in order that those in favour could sign it separately in addition, so that, as the matter finally stands, the Convention proper is signed by 26 nations; then comes our article with its regulations, which is signed again by 20 nations. The nations not signing our article are Great Britain, Italy, Japan, Mexico, Persia and Portugal.

The American article is the most important of the whole Convention, because it is new matter. When the Conference was called, it was practically a foregone conclusion that

some kind of an agreement would be reached as regards ship to shore communication, and the vote for Great Britain's proposition when we finally reached it was practically unanimous.

The preliminary Conference of 1903 showed that the majority of the nations represented were in favour of ship to shore communication without regard to system.

The Conference of 1906 while confirming the previous one, has shown that the majority of the nations represented are in favour of ship to ship communication, but unlike the Conference of 1903, there is now a convention to that effect in binding form, subject only to the ratification of the different Governments.

F. M. Barber,
Commander U.S. Navy, Retired.

Paris, *November 18th*, 1906.

Nernst Lamp Renewals.

The correspondence on this subject is particularly interesting, and Mr. Hanson's letter giving his Stirling experience of 1-ampere multiple Nernst lamps is very much to the point. I had occasion some months ago to recommend one of the largest local firms to install a fair number of 1-ampere and of ½-ampere multiple Nernst lamps, and the result has been to confirm what other engineers have found to be the real life of such burners. The makers appear to think that some 7½ renewals per annum for the 3-burner Nernst multiple lamp is ample provision for renewals, but they do not seem very disposed to back up this opinion by contracts for the supply of replacement burners. The point cannot be driven home too clearly that the annual cost of current plus all renewals, is the information required by a consumer before deciding to adopt this or any type of lamp, and while the Electrical Co. are always advertising the Nernst lamp as being the best means of fighting the competition of incandescent gas, they are a little weak when it comes to definite data to support this claim. It is frequently the case that makers of lamps state that any trouble which may be experienced by one engineer is due to his using alternating current, and for this reason the facts related as having been experienced at Stirling, where the supply is direct current, are of very great interest to me. There is no difficulty in ascertaining the hours of burning of any lamp, because a number of hour meters are now on the market, any one of which will give this information directly. I tried the Nernst lamps for street lighting in Islington, and have had them in use here for the same purpose for several months, and the records are fairly complete, but they do not show that the causes of the vagaries in the life of different burners have been ascertained and eradicated by the makers. Taking your issue of the 16th inst., it would appear that at Kilmalcolm the Nernst lamps are giving place to large-bulb high-efficiency carbon filament lamps; that at Gloucester, most of the Nernst lamps have been taken out; that at Stirling they have suffered from the vagaries of the Nernst lamp, and the only reply that the Electrical Co. can give is that the Nernst lamps "if correctly installed and maintained give less trouble than arc lamps." What is meant by "giving less trouble" is not explained. The information that engineers and consumers require is the cost of maintenance, and upon this point no information is given.

C. H. Yeaman.

Hanley Electricity Works,
November 16th, 1906.

I have in use a number of Nernst lamps of ¼, ½ and 1 ampere size, and the latter I find a fair success, but the ¼ and ½ ampere D-type burners are a failure. With the 1-ampere burners, the chief trouble is due to the filament breaking, evidently during cooling after switching off. Another defect is the occasional variation of candle-power of different burners. Certainly, the current consumption has varied in proportion, but where there are two or more lamps close together, the difference in brilliancy is most marked.

The cut-out has, in my opinion, received more than its fair share of the blame, and the frequent failures of the heaters of the D-type burners are, I consider, due to faulty design. Having tested a number of faulty heaters, I have almost invariably located the break in the centre of the coil opposite the point where the burner is connected to the leading-in wires, and I attribute this to the heat of the burner keeping the heater coils at this point in a state of incandescence, and hence there is soon trouble.

Some time ago I fitted up an ammeter with a range up to 5 amperes, and I find this a useful method of testing doubtful lamps, for as soon as the current flows through the burner it is possible to observe by the kick of the pointer whether the cut-out is working or not.

I have lately been trying the new vertical burners for the ½-ampere D-type lamps, and up to the present they are giving much better results, and I certainly think the makers would be wise to adopt that type for the ¼-ampere also.

F. C. Curel,
Engineer and Manager.

Witney Electric Supply Co., Ltd.,
November 17th, 1906.

In view of the recent correspondence in the ELECTRICAL REVIEW on the life of the Nernst burner, I should like to state that my experience with this type of lamp is far from that of many of the writer's. The new A.D. type ½-ampere burner is giving excellent results in Leigh, and I am encouraging the use of it. The ¼-ampere I find also satisfactory, if the lamp body is in working order at first. I know many burners have been blamed on account of the cut-out sticking up. The lamp lights at first, and then refuses to even heat, the burner is discarded and another one inserted, which lights up a time or two then fails. Now, the fault is not with the burner, but in the cut-out, and all that is necessary is to bend the magnet slightly outwards, thus giving the cut-out more space in which to move. I think it probable that in the near future the A.E.G. will be placing on the market a ¼-ampere of the same type as the new A.D. burner, and then we shall probably hear less complaints.

I think that the Nernst lamp is a great factor in competing with the incandescent gas, and for this reason I have recently introduced a scheme for the maintenance of consumers' Nernst burners at a fixed charge per lamp per annum. By this means the consumer will get an excellent light at a low cost for energy, and he will know exactly what the cost of maintenance will be. I have recently installed 3-ampere Nernst projector lamps in the Municipal Technical School and these also are giving excellent results.

I notice that Mr. Hanson mentions that he has also suffered from the vagaries of the Nernst lamp; I am afraid that in many cases the Nernst lamp has suffered from the vagaries of the generating station.

Arthur T. Smith,
Borough Electrical Engineer.

Leigh, Lancashire,
November 17th, 1906.

The Commercial Development of Electricity Supply.

I have read with great interest Mr. Matthews's useful articles on "Some Practical Notes on the Commercial Development of Electricity Supply Undertakings" now appearing in the ELECTRICAL REVIEW, and venture to make a few comments on them, in the hope of obtaining a little further information from other engineers who have had experience in this direction. The whole question depends on the education of the general public to a greater appreciation of the convenience and possibilities of electricity in the house; it is difficult to see how this can be accomplished satisfactorily by any means other than the establishment of a new business department; energetically and tactfully managed there is no doubt that such a department can be a very profitable one. Mr. Matthews's arguments, on the whole, are so sound that it is, perhaps, rather like splitting hairs to disagree with him, but I am strongly of the opinion that it is a necessity for canvassers to be technical men. The curious questions that people ask about "electricity" are astonishing, and in order to obtain new business it is

often essential to diverge into side issues. The recommendation of local advertising is, I think, a mistake. Experience seems to prove that to make advertising pay it is necessary to advertise wholesale. It would be useful if Mr. Matthews would give us his experience on the value of exhibitions, and some idea of a suitable scheme for co-operation with landlords and others interested in the building trades.

H. S.

Suction Gas Power.

Referring to the leaderette in your issue of November 16th on the above subject, it will, we feel sure, be of further interest to you and your bashful correspondent to compare the figures in the two tables which we enclose with the estimate he has formed.

Guernsey Steam and Gas-Driven Electric Station.
Cost of Working, 1905.

—	Steam plant. Lighting load. Per unit generated.	Gas plant. Power load. Per unit generated.
Coal, including steam pumps, air pump, forced draught at steam station ...	·436d.	·200d.
Oil, waste, water, stores	·037d.	·042d.
Wages	·214d.	·133d.
Average hours of attendance to run plant when necessary per day ...	18	13
Repairs, buildings, machinery, transformers, mains, accumulators ...	·250d.	·123d.
Total works costs	·937d.	·498d.
Units generated	500,430	718,858
Average per cent. of full load at which engines were loaded during the time of running	68½ per cent.	86¼ per cent.
Coal used per unit generated	4·97 lb.	2·21 lb.
Price of coal in bunkers. Washed anthracite peas used at each station	16s. 2d.	15s. 6d.

These figures are *actual figures*, not estimated. They have been furnished to us by the purchasers and users of the plant in question, and, as you will see, knock the bottom out of your correspondent's conclusions. It is true that the dynamos are of 180-KW. capacity, not 200-KW., but at both stations they are alike in that respect.

It would appear that some readjustment of the resultant curves is necessary if we are to get at the truth of this question, for which we all appear to be striving so earnestly.

We have not time to notice in detail many of the inaccuracies in the estimate, but call attention to the calorific value of the anthracite given as 12,550 per lb. Low's text-book gives it as 14,000 to 16,200, average 15,000; Fowler's as 15,250; so your correspondent must have got hold of the wrong book, or a rather dirty sample of coal.

Perhaps, by estimating the steam coal at about 3s. per ton, or pushing up the price of the anthracite proportionately, the resultant figures might be made to support the interest in which they were compiled. We offer this as a suggestion.

The Campbell Gas Engine Co., Ltd.
W. Marsden.

Halifax, *November 19th*, 1906.

P.S.—The Guernsey gas plant is not a suction plant, but a pressure plant without boiler. A blower, motor-driven, was substituted for the boiler about two years ago, so that it is working practically on the same lines as a suction plant, though the capital cost was, of course, much more on account of the gas-holder, &c.

[A description of the Guernsey stations in question was given in our issue of December 2nd, 1904, in an abstract of a paper by Mr. H. Campbell.

Some allowance should be made in comparing the plants for the lower output and load factor of the steam station, which was running on a lighting load, while the gas station was supplying power.—Eds. E.R.]

Application of Magnetic Brakes.

The unfortunate accidents that happened during the summer, and the publication of Col. Yorke's report on the Highgate disaster, have led to a good deal of discussion on the all-important question of braking, and a comparatively distinct difference of opinion has emerged as to whether it is best to have an emergency brake pure and simple or to rely on the service brake.

You in your leading article of November 9th, and Mr. Pringle in his letter in this week's issue, are strongly in favour of a separate emergency brake, that is, independent of the service one, whereas, Col. Yorke recommends the use of the service brake.

There are very weighty arguments in favour of both these views, and it will probably be difficult to arrive at a unanimous conclusion.

In the consideration of this question there is one side of it that does not get all the attention it deserves, although it really is the governing factor.

Every engineer who has responsible charge of power vehicles, whether trams or motor-'buses, will heartily endorse Col. Yorke's remarks as to the necessity for more accurate attention to brake adjustments; but it is very seldom indeed that sanction can be obtained for the expense necessarily entailed; especially in municipal tramways, for the simple reason that those who have to authorise have not the knowledge to appreciate the necessity, and often—for political reasons—ignore their engineer's recommendations.

How often is an engineer authorised to do all he knows to be necessary?

Consequently, brake systems must be designed to give maximum safety with minimum intelligence in working, that is to say, the *man factor* must be the governing one, and this, as I have above stated, is seldom given full weight.

The case of Driver Cone is typical; here we had a man with the minimum of experience, suddenly plunged into a new one—one that, I venture to suggest, would have tried the nerves of the stoutest—and he did a perfectly natural thing; he *persisted* in the operations he had previously been performing; what he ought to have done, was "to entirely release the hand-brake," *i.e.*, totally *reverse* his previous operations, and that at a moment of the greatest stress the human mind can be submitted to; the result we know, and I for one, whilst deploring it, would hesitate much before condemning him.

The first rule I would deduce is: Have a brake system such that all braking operations, whether performed by hand or automatically, shall be persistently progressive.

The law on which this rule is based is fundamental, and applies with especial force to the human factor in brake operations.

As an ideal which I know is attainable in a degree, and as an illustration, I would suggest a combination embodying the requirements set out in Col. Yorke's report, and meeting, to some extent, Mr. Pringle's objections.

Arrange your hand brakes so that they are operable within a definite space off locking point; further advance of brake handle to bring into action a brake which will automatically reach its maximum effect; and for use *in extremis* have a real emergency brake, operable at both ends of the car, in the simplest possible manner, by anybody. Such an emergency brake must be of the type you refer to in your footnote to Mr. Pringle's letter.

With such an equipment, all you have to teach your drivers is: In emergency, keep on winding your brake handle.

For extreme cases, conspicuous instructions could be posted at both ends of car, so that any person who had retained sufficient presence of mind could operate the "last hope."

Geo. W. Green.

London, S.E., *November 19th*, 1906.

Engineering Specifications.

Referring to Sir Alexander Kennedy's recent presidential address to the Institution of Civil Engineers, I trust that his weighty words in reference to the inadvisability of making the engineer the arbitrator in relation to his own specification will lead to the abolition of this custom.

You are aware that the Institution of Electrical Engineers some few years since formed a representative committee of manufacturers, contractors and consulting engineers to consider the use of model general conditions of contract, with the result that a form of model general conditions was agreed upon and has since, I am glad to say, been almost universally adopted by the profession in connection with contracts for electrical machinery and apparatus.

The point raised by Sir Alexander Kennedy was carefully considered by that committee, with the result that one of the model general conditions is as follows :—

Arbitration.—If at any time any question, dispute or difference shall arise between the purchasers or their engineer, and the contractor, upon or in relation to or in connection with the contract, either party may forthwith give to the other notice in writing of the existence of such question, dispute or difference, and such question, dispute or difference shall be referred to the arbitration of a person to be mutually agreed upon, or, failing agreement, to some person appointed by the president for the time being of the Institution of Electrical Engineers.

Work under the contract shall continue during the arbitration proceedings.

The award of the arbitrator shall be final and binding on the parties. Upon every or any such reference, the costs of and incidental to the reference and award respectively, shall be in the discretion of the arbitrator, who may determine the amount thereof, or direct the same to be taxed as between solicitor and client, or as between party and party, and shall direct by whom and to whom, and in what manner the same shall be borne and paid. This submission shall be deemed to be a submission to arbitration, within the meaning of the Arbitration Act, 1889.

Prior to the settlement of these model conditions, it was a general practice for engineers and their clients to put into their conditions of contract not a few stipulations under which the engineer had the sole and final decision on many important matters, with the result that, in spite of the inclusion of an arbitration clause, its operations were materially restricted. In one contract, which I have before me at the moment, I find some half-dozen references to points upon which a difference might, and probably would, arise between the contractor and the engineer. In each case it is stipulated that "the engineer shall determine them, and his decision shall be final," and there is a general stipulation that "the decision, in writing, of the engineer upon any matter as to which he is, by these general conditions, required or authorised to certify or decide, shall be final and binding."

In the model conditions of the Institution of Electrical Engineers no such unreasonable stipulations will be found, and under the arbitration clause any dispute whatever between the engineer and the contractors may be referred to an independent decision.

I hope that the Engineering Standards Committee will not consider it outside their province to issue a form of model general conditions for engineering contracts, based, I trust, upon those which, after so much careful consideration, have been issued by the Institution of Electrical Engineers.

Robert Hammond.

London, S.W., *November 19th*, 1906.

[As our readers are aware, the practice rightly condemned by Mr. Hammond is one which we have fought against for years, and we shall be very glad to see it abolished.—EDS. E.R.]

[Several letters, received too late for insertion, have been held over.—EDS. E.R.]

Trade Opening.—The British Vice-Consul at Vera Cruz (Mr. Nunn) reports that a company has been formed to take in hand the construction of warehouses, extra wharfage, and the other general improvements. As the company will be registered in London, Mr. Nunn says British manufacturers would do well to keep the movements of this new enterprise in view, in order to make an effort to secure the large orders that will be placed for cranes (probably electrical) and general labour-saving devices, structural iron, steel and cement for the many buildings required, a full hotel equipment, a coal-discharging plant, a dredger, a steam cutter, and the more or less general equipment incidental to the requirements of a dock company.—*B. of T. Journal.*

BUSINESS NOTES.

Book Notices.—*L'Ozone.* By Emile Guarini. Pamphlet of 24 octavo pages. Paris: H. Dunod and E. Pinat.—The question of sterilisation of drinking-water and other fluids by the use, in one form or another, of nascent oxygen, is at the present time engrossing the attention of many scientific and practical men. Those who have as yet not studied the matter very fully will find this pamphlet most useful, as giving a lucid *résumé* of the principles of the work and descriptions of leading actual examples. After describing the nature and effect of ozone, the author dwells upon its value as a bactericide, and its application for sterilising both air and water. He notes the various electrical methods of obtaining it direct from the atmosphere, such as the Siemens and Halske plant (which has been described in this journal), and the well-known installation at St. Maur, designed by M. de Frise. At St. Maur water is taken from the Marne, passed through sand or flint filters and subjected to aeration by ozone in towers filled with gravel. The installation employs a motor of 45 H.P., and is capable of sterilising water for a population of 35,000. The pamphlet concludes with a reference to various other applications of ozone to industrial processes.

"History of Automatic Electric and Electrically-Controlled Fluid Pressure Signal Systems for Railroads." By William Robinson. Brooklyn, N.Y.: The Author, 672, Putnam Avenue.

"Proceedings of the Engineers' Club of Philadelphia." Vol. XXIII. No. 4. October, 1906. Philadelphia, Pa.: The Club.

"Bread and Butter Studies and their Relation to the Higher Education of Workmen." By Wm. Ripper. An address to technical students. London: Longmans, Green & Co. 1906. 6d. net.

"Dinamometri." By E. N. Campazzi. Milan: Ulrico Hoepli. 1907. L. 3.

"Elettromotori Campioni e Metodi di Misura delle Forze Elettromotrici." By Dott. G. P. Magrini. Milan: Ulrico Hoepli. 1907. L. 2.

"Engineering in the United States." By Frank Foster. London and Manchester: Sherratt & Hughes. 1s. net.

"Fowler's Electrical Engineer's Handbook and Directory of Light, Power and Traction Stations." Manchester: The Scientific Publishing Co. 1907. Price 2s. 6d. net and 3s. 6d. net.

Practical Engineer Electrical Pocket-Book and Diary for 1907. Manchester: The Technical Publishing Co. Price 1s. net and 1s. 6d. net.

"Die Gleichstrommaschine." By E. Arnold. Vol. I. Theory and experiments. Second edition. Berlin: Julius Springer. Price M. 20.

"Zur Theorie der Abschmelzsicherungen." By Geo. J. Meyer. Munich: R. Oldenbourg. 1906. Price M. 3.

Linolite.—We learn that the LINOLITE CO., of Westminster, have just dispatched 1,000 ft. of Linolite to their agents in Bombay, in fulfilment of an order placed with them in connection with the coming visit of the Ameer of Afghanistan to India. It is not generally known that "The Field of Waterloo" is lighted by Linolite, but the fact was noticed at the Royal United Service Institution on Wednesday evening, 14th inst., when the Society of Engineers held their annual conversazione.

Catalogues and Lists.—THE SUN ELECTRICAL CO., LTD., Charing Cross Road, W.C.—Circular giving particulars and prices of "Sunlite" reflectors, arranged for use with the tantalum lamp.

THE GENERAL ELECTRIC SIGN AND ENGINEERING CO., LTD., 15, Dufferin Street, Bunhill Row, E.C.—An illustrated price list of the company's patent electric GE-SE signs, with descriptive matter.

THE VAUGHAN PULLEY CO., West Gorton, Manchester.—Illustrated catalogue of the firm's specialities in pulleys, with tabulated pulley data attached.

ROBERT SPENCE & SON, Trafalgar House, Richmond, Yorks.—A circular and price list dealing with Spence's patent "Omnium" oil ejectors. These oilers are worked by compressed air contained in the body of the plunger, and it is claimed that they will oil drop by drop, by gravity, or will eject the oil to a distance of 15 ft. They are simply constructed, and can be adjusted to oil in any direction.

THE ELECTRIC AND ORDNANCE ACCESSORIES CO., LTD., Stellite Works, Birmingham.—Leaflet, F 71, giving particulars and prices of the Stellite electric radiators; and leaflet, M 262, dealing in a similar manner with the Stellite flexible shafts, and illustrating their application to electric drilling and grinding.

THE ROCKWELL-WABASH CO., LTD., 69, Milton Street, E.C.—List giving particulars of the company's well-known vertical files, catalogues and cabinets.

MAX KOHL, Chemnitz.—Supplementary catalogue, following catalogue No. 21; this is a very comprehensive work, giving prices and full particulars of an immense variety of physical and chemical apparatus, mechanical models, &c. Few such price lists can be more complete than this. We understand that a new list of Roentgen-ray apparatus and high-frequency apparatus is also appearing this month.

MESSRS. SIEMENS BROS.' DYNAMO WORKS, LTD., York Mansions, Westminster.—October price sheets, Nos. 21 and 15 F, dealing with incandescent and tantalum lamps and accessories. Also an attractively designed and coloured tantalum lamp show card (about 16 in. × 11 in.), which emphasises, pictorially, the manner in which the new lamp puts gas in the shade.

The Combination Metallic Packing Co., Ltd., Hillgate, Gateshead-on-Tyne.—Three pamphlets describing and illustrating the company's metallic packing for marine and land engines, with lists of firms using the same; also a leaflet with attached sample of the C.M.P. high-pressure metallic joint ring.

The November issue of the "Tyneside Electrical Pioneer," to hand, continues the seemingly very effective crusade of the Tyneside power companies in the interest of electricity. The issue in question contains typical illustrated articles on lighting and power applications, advertising, &c., and records the lamp connections (4,800 8-c.p.) during the month of the associated Newcastle-on-Tyne and Durham Companies as an instance of the remarkable progress of electric lighting in the area in question.

Messrs. Elliott Brothers, Century Works, Lewisham.—Booklet giving description of the Century Works, and a short history of the firm, which was established in 1800; also particulars of the various types of instruments, testing sets, telegraph apparatus, indicators, rheostats, switchgear, &c., for which the firm is noted. An interesting section deals with the "Century" die casting process, by means of which complicated parts of instruments are cast of an alloy of aluminium and zinc, needing no further machining.

The Switchgear Co., Ltd., Newhall Street, Birmingham.—Leaflets relating to magnetic blow-out fuses for direct currents, and to main lighting and traction switchboards erected by the company.

Trade Announcements.—The Mirrlees Watson Co., Ltd., has removed its London office from No. 158 to No. 139, Gresham House, Old Broad Street, E.C.

Messrs. Home & Rowland, of Old Charlton, Kent, state that they have recently enlarged their workshops and installed new machinery in order to be able to deal promptly with an increasing business in dynamo and motor repairs and the manufacture of transformers, in both of which lines they specialise.

Messrs. J. G. White & Co. inform us that they have adopted new telephone numbers, as follows:—3306-7-8 London Wall, 9886 Central.

Messrs. Watlington & Co. inform us that owing to the expiration of their lease at 59, City Road, they are removing their offices to Moorgate Station Chambers, E.C., and their stores to 6, Union Street, Moorfields, E.C., which will be their address after the 19th inst.

The Union Cable Co. wish it to be known that their address is now 27, Eagle Wharf Road, N.

Messrs. Lord & Shand, Ltd., electrical engineers, have opened new premises at 24, Lockyer Street, Plymouth.

The Rhodes Electrical Mfg. Co. Ltd., inform us that Messrs. T. Hood & Co., Ltd., of 26, Bath Street, Bristol, no longer represent them in the South Wales district; until fresh arrangements are made all communications in that district should be addressed to their head office, Riverside Works, Doncaster.

Electrical Exhibition.—An electrical exhibition is to be held at the Hounslow Baths in February next, for one week, by the Heston and Isleworth U.D.C., under the management of Mr. P. E. Rycroft, electrical engineer and manager to the Council. Electric current will be supplied free of charge, and the co-operation of the electrical trade is invited. Every endeavour will be put forth to make the exhibition a success, both socially and commercially. Address Mr. Rycroft, at the Electricity Works, Bridge Road, Hounslow.

Irish Copper.—It seems that there is some prospect of a revival of the copper mining industry in Ireland; the Bonmahon Copper Mines Development Syndicate is taking steps towards the reopening of the once prosperous Bonmahon mines, which were shut down 30 years ago on account of the low price of copper at that time—£35 per ton. The price is now over £100.

Deep Leads Electric Transmission Co.—The petition of the Victorian Deep Leads, Ltd., and others for the compulsory winding up of the Deep Leads Electric Transmission Co., Ltd., was mentioned to Mr. Justice Warrington in the Chancery Division on Tuesday. The petition is to stand over for a month.

Geneva Tramways Co.—In the Chancery Division on Tuesday, Mr. Justice Warrington heard a petition by the company and its liquidator for sanction to a scheme of reconstruction. Counsel stated that the company was registered in December, 1901, with a capital of £850,000 in £1 shares, for the purpose of acquiring the shares in a Swiss company owning a concession for running tramways in Geneva. The capital of the new company, which would take over the company's undertaking, would be £550,000 in £1 shares, with an authorised issue of £300,000 debentures. The consideration for the sale was to be £540,000 in shares and £255,000 in debentures. The shareholders of the old company would not get anything; the 4½ per cent. bearer debentures and income certificates would get 510,000 shares and the whole of the £255,000 debentures, and the third debentures 30,000 shares. That would leave 10,000 shares and £45,000 debentures to be dealt with, if necessary. The resolutions had been unanimously approved. His Lordship sanctioned the scheme.—*Financial Times.*

Transparent Bell-Push.—We illustrated and described the Wilks transparent bell-push in our issue of October 27th last year, and we now understand from Messrs. Evered & Co., Ltd., of Drury Lane, that since they placed it on the market, a large number have been sold. It has become quite popular with medical men having a private practice.

Dissolutions and Liquidations.—Imperial Electric Lamp and Battery Syndicate, Ltd.—A meeting is to be held at 82, Bishopsgate Street, E.C., on December 21st, to hear an account of the winding up from the liquidator, Mr. A. Sissons.

Christy Bros. & Middleton, consulting and contracting electrical engineers, Chelmsford.—Messrs. F. and L. F. Christy and W. Middleton have dissolved partnership so far as concerns the last-named partner. The business has been acquired by Christy Bros. & Co., Ltd., who will attend to debts.

Barcelona Tramways.—A general meeting of this company was held on the 14th to hear an account of the winding up from the liquidator, Mr. J. Barber Glenn. The total receipts amounted to £520,723, out of which the 5 per cent. debentures with interest absorbed £45,895, the 4½ per cent. debenture stock, with interest and premium, £68,473, and the preference shares, with accrued interest, £102,160. The ordinary shareholders had received £14 10s. per £10 share or £290,000 in all; £4,000 was due to the directors, and sundry expenses amounted to £8,981. After meeting all claims a sum of £1,083 or 1s. 8d. per share remained, with which it was proposed to make a final distribution of 1s. per ordinary share, and any balances left over were voted to the liquidator in view of the protracted period over which the liquidation had extended. The final distribution on the ordinary shares will be made on the 23rd inst.

De Lacy Bros., electrical engineers, Liverpool.—Notice is given in the *London Gazette* of the release of trustees on the 5th inst.

London Electrical Syndicate, Ltd.—This company is winding up voluntarily, with Mr. W. R. Gaff, of 53, New Broad Street, E.C., as liquidator.

Calais Tramways Co., Ltd. (in liquidation).—Creditors should send particulars of debts to Mr. E. C. Price, the liquidator, at 57, Moorgate Street, E.C., on or before December 31st, 1906.

Tangye Tool and Electric Co., Ltd. (in voluntary liquidation).—A meeting will be held at Cornwall Works, near Birmingham, on December 20th, to receive an account of the winding up from the liquidator.

LIGHTING and POWER NOTES.

Australia.—N.S.W.—Messrs. Noyes Bros. have just completed an extensive addition to the E.L. plant of the Newcastle (N.S.W.) Municipal Council. Some 16 years ago an electric lighting plant was installed at a cost of £5,000. The new machinery consists of two large B. & W. boilers, each of which will evaporate 6,500 lb. of water per hour; the generating sets consist of two Belliss & Morcom engines, coupled to British Westinghouse generators, each of 100 kw. capacity, single-phase, with a periodicity of 50 cycles per second, and working at 1,150 volts.

By way of experiment, the Council is also trying 12 flame arc lamps for street lighting.

Bolton.—A L.G.B. inquiry was held on November 14th into the application of the T.C. for a loan of £20,000 for electric lighting. There was no opposition.

Bo'ness.—The T.C. has approved a draft copy of the statutory notice for a prov. order in connection with the electric lighting scheme for the town. The object of the Bill is (1) to confirm the agreements at present existing between the T.C. and the National Electric Construction Co., and (2) to empower the Council to borrow more money to carry out extensions to the system.

Canada. — Toronto. — Our Toronto correspondent, writing on November 6th, stated that a supply of electrical energy from Niagara was expected within the next two or three weeks, and would necessitate a number of changes by the users of power. The Toronto Electric Light Co. has spent over £50,000 on installing a suitable plant for the reception of this supply, while the Toronto Street Railway Co. has similarly expended something like £40,000. It is stated that the electric companies contemplate an increase in the voltage all over the city from 110 and 220, as at present, to 250 and 500 volts. This will necessitate an enormous aggregate expenditure on the part of power users. The matter of increased voltage is now under consideration, and should the alteration be made, proper appliances will be insisted upon by the insurance companies.

Later advices received in this country state that the practical fulfilment of the scheme for utilising the energy of the Niagara Falls to provide electrical power at Toronto, which is situated 75 miles away, has taken place this week.

Ottawa.—The Jordan Light, Heat and Power Co. and the Erie and Ontario Development Co. will apply to the Dominion Parliament at the forthcoming session for an Act confirming their agreement to amalgamate under the name of the Jordan-Erie Power Co. The joint concern will seek authority to take water direct from Lake Erie, as well as through the Niagara and Welland Rivers, and for this purpose desires to construct a canal through the townships of Wainfleet, Pelham, Gainsborough, Louth and Clinton, and to dredge the south branch of the Welland River.

Continental Notes.—Germany.—The report of the Berlin Electricity Works Co. for 1905-6 states that the sales again increased, the figures being 128 million kw.-hours, as compared with 111 millions in the preceding year. As a result of the new

connections to the distributing mains of the company, which latter has a monopoly of electric lighting supply in the German capital, the number of incandescent and Nernst lamps supplied rose from 619,625 in 1904-5 to 723,334 in the past year, the arc lamps advanced from 26,012 to 30,296, the motors from 15,403 of a total of 55,666 H.P. to 18,423 of 68,310 H.P., and the apparatus from 2,068 to 2,741 respectively. Various extensions of plant were carried out during the year, and the stations have now reached the limit of their capacity as provided under the agreements with the Berlin Municipal Council. The financial position of the undertaking is briefly as follows:—

	1905-6.	1904-5.
Share capital	£1,575,000	£1,575,000
Bonds	1,990,000	1,718,500
Gross profits	570,918	493,588
Net profits	261,130	238,282
Profit share of Berlin municipality	89,492	79,760
Dividend, per cent.	10	10

As the company is now unable to accept any new customers owing to the plant at its generating stations being fully loaded, the Berlin Municipal Council has been approached with a view to a modification of the agreement with the company, so as to enable it to carry out further extensions, one of which would be the erection of a new station of a capacity of 15,000 H.P. The proposals made by the company have been placed before the Municipal Council, and in the event of their being approved not later than December, it is expected that the extensions would be completed by the next autumn.

ITALY.—The authorities of the Province of Bergamo have granted a concession to the Società per la Ferroria Elettrica di Valle Brembana to put down a plant to utilise the water-power of the River Brembo, at St. Pietro d'Orzio, in the generation of electrical energy for the operation of the Bergamo-St. Giovanni-Bianco Railway.

SPAIN.—A central station has recently been completed and put in operation at Villavieja (Salamanca) by the Sociedad Hidro-Electrica del Aqueda. Water-power is utilised, and the electrical energy generated is being utilised for lighting purposes in a number of small towns in the district.

SWEDEN. — A correspondent of the *Pall Mall Gazette* states that for nearly twelve months practical tests have been in operation, in Sweden, for placing the whole of the railway system of the country under electric traction, and results have been obtained which some time since induced the Government to take a decisive step. At the falls of Gullspang there is now being built a power station which is to have a capacity of 150,000 H.P. This installation, when completed, will furnish energy for industrial and illumination purposes for the whole of central Sweden. The cost of construction is put at five million Swedish kroner, and it is anticipated that it will result in reducing by 1½ million kroner annually the cost of foreign coal in Sweden.

Cheadle and Gatby. — The U.D.C. has approached Stockport T.C. with reference to the taking over of the Council's E.L. order, 1900; before coming to any decision the Stockport Council has intimated that it desires proof that the undertaking would be a success, and that electricity would be utilised for public lighting. A poll of the ratepayers on the subject is proposed.

Coventry.—After a long and animated discussion, the City Council decided, on Tuesday last, to refer back for reconsideration the minutes of the E.L. Committee relating to the recent breakdown of a boiler at the electricity works, in order that a full report on the whole situation might be presented.

Dover.—Application has been made to the L.G.B. by the Corporation, for sanction to borrow the sum of £7,500 for electrical purposes.

Eastbourne.—A L.G.B. inquiry was held on November 14th relative to the T.C.'s application for a loan of £10,890 for E.L. purposes. There was no opposition.

Elgin.—The T.C. has decided to drop the question of electric lighting for the town for the time being.

Harpenden.—The U.D.C. has appointed a sub-committee to carefully consider the application for an E.L. prov. order by the North Metropolitan Electrical Power Distribution Co.

Herts.—The North Metropolitan Electric Power Supply Co. is applying for a prov. order for E.L. in the districts of Hendon, Barnet, Edmonton, Ware, Hertford, Hatfield, Welwyn and St. Albans.

Hindley.—The U.D.C. has asked the Wigan T.C. and the Lancashire Electric Power Co. (which is applying for a prov. order for E.L.), the terms upon which they would be prepared to supply energy in bulk, if the Council's order is put in operation.

Irvine.—The B. of T. having called the attention of the U.D.C. to the fact that the E.L. Order, 1903, has not been carried out, the Council has replied that, in view of the fact that a considerable section of the ratepayers are not in favour of a municipal scheme, it has been decided to abandon it.

Lancashire.—A prov. order for E.L. at Haslingden Rawtenstall, Bacup and Ramsbottom is being applied for by the Lancashire Electric Power Co.

Launceston. — The T.C. has agreed to write to the Electric Supply Corporation to know if it intends to take any action in the lighting of the town by electricity.

Liversedge.—The Electrical Distribution of Yorks, Ltd., has given notice of its intention to apply to the B. of T. for a prov. order for electric lighting in the district.

Llandrindod Wells.—The E.L. Co. has informed the U.D.C. that it is prepared to enter into negotiations with the Council for the purchase by the latter of the undertaking, but the directors did not consider it opportune to discuss the terms of sale until the Council was in a position to carry the negotiations to a successful issue.

London.—WOOLWICH.—At the meeting of the B.C. on the 15th inst., the Finance Committee reported the receipt of a communication from the L.C.C. in reference to an excess expenditure of £5,645 on capital works in connection with the electricity undertaking, and drawing attention to the fact that a sum of £655, borrowed in 1905 (for the site of a sub-station at Eltham) as part of a loan of £9,169, had not been debited to the electricity account. The Committee recommended that application be made to the County Council for sanction to borrow £5,645, and that the £655 for the Eltham sub-station be debited to the undertaking. In the course of the discussion which ensued, Ald. Widger accused the Labour Party, who were in power before the late elections, of juggling with the accounts of the electricity undertaking. Mr. Jenkins Jones said the affairs of the undertaking under the rule of the Labourites, were in a state of chaos. The Committee's recommendations were carried.

Mansfield.—On November 15th the L.G.B. inquiry into the application of the T.C. for a loan of £8,000 for E.L. purposes was resumed. The Inspector objected to a number of items under 10s. being included in the loan, and said that the undertaking should not be charged with the cost out of capital of goods that had not a year's life. The Inspector also expressed a hope that excess expenditure on loans would be stopped.

Paignton.—The U.D.C. has received an offer from Dr. J. A. Purvis, of Exeter, to form a company to erect a refuse destructor and small electric light installation combined, provided the Council entered into an agreement to destroy the town refuse in the destructor, purchase clinker for road making purposes, and take electrical energy for 13 arc lights, the Council to have the option of taking over the undertaking as a going concern at the expiration of 15 years. The Committee recommended that Dr. Purvis be informed that the Council would be prepared to support the application of the company in obtaining a prov. order for electric lighting purposes, provided satisfactory terms could be arranged, and an undertaking being given by Dr. Purvis to pay the sum of £300, the cost of the old order, and to defray other expenses of the Council in the matter.

Penge.—The South Metropolitan E.L. and P. Co. has offered to supply the U.D.C. with energy for street lighting a 1½d. per unit. The agreement with the original company was that energy for street lighting should be supplied, if required, at 3d. per unit.

Penrith.—The U.D.C. has decided to apply to the B. of T. for a provisional order enabling the E.L. Order, 1900, to be transferred or leased to the local E.L. Co.

Pontefract.—The T.C., on November 14th, decided to apply for a prov. order for E.L. A similar application is being made by the Electrical Distribution of Yorkshire, Ltd.

Radcliffe.—The U.D.C. has fixed the minimum charge per quarter for a supply of energy at 5s.

Salford.—Mr. M. K. North, on Tuesday, held an inquiry at the Salford Town Hall, with reference to an application by the Corporation Electricity Committee for power to borrow £25,000 for extensions, mains, &c.; and £10,000 for the purchase of motors. It was explained by the borough electrical engineer (Mr. Taite) that last year the net profits of the department amounted to £14,891. During the last two years power requirements had increased by 150 per cent., and lighting by 44 per cent. The inspector impressed on the Committee the necessity of having a substantial depreciation fund; and Mr. Elliott said he believed the majority of the members of the Council recognised that fact. £10,000 was paid last year, he added, in relief of the local rates. Mr. Taite said that when they last borrowed £25,000, it was expended in two years, and they estimated that the sum now asked for would suffice for the next two years. The money was really required for working capital. There was no opposition to the application.

Mr. C. D Taite, the borough electrical engineer, speaking at the fourth annual dinner on Saturday evening last of the employés of the Salford Electricity Works, said the object they had had in view for several years—to obtain the lowest cost of production per unit—had been achieved this year, and they were, so far as electricity was concerned, at the head of all municipalities in the country. The whole of the large plant is now at work.

St. Albans.—A prov. order to enable the undertaking of the St. Albans and District Electric Supply Co. to be transferred to the North Metropolitan Electrical Power Distribution Co., Ltd., is being applied for.

South Africa.—The Cape Parliament has voted £50,000 to be expended in electric lighting on the Eastern and Midland Railway systems. The money voted will be principally expended on the "Stone" system of train lighting; the lighting of some of the more important railway stations is, however, included in the vote. The Western Railway system has had the advantage of electric lighting for several years, the carriage lighting being effected by an oil engine and dynamo in the brake van of each train.

Potchefstroom.—It is recommended by the Works Committee that an application be made by the T.C., to the Colonial Secretary, for provisional sanction to a scheme for the electric lighting of the town, at a capital expenditure not exceeding £15,000. The electric lighting of the town is at present in the hands of a private company, the consumers numbering about 100.

Durban.—The T.C. on the 25th ult. resolved that the minimum charge for energy to storekeepers be reduced from 10s. to 5s. per month. The borough electrical engineer reported very fully in regard to supplying energy at a cheap rate from midnight to 5.30 p.m. for purposes of heating and cooking, &c. After considering the matter, the T.C. resolved that on and after a date early in the next year, all consumers of energy for heating and cooking purposes be supplied during that period at the following rates—the exceptions to these rates being wholesale and retail stores, or other places of business:—Between the hours of 5.30 p.m. and midnight 8d. per unit, less 10 per cent. discount for prompt payment; after midnight and up to 5.30 p.m., 1½d. per unit, without discount. A minimum fee of 5s. per month to be charged for this latter service. At the same meeting it was also decided, on the recommendation of the borough electric engineer to purchase an "underfeed stoker" at a cost of £288 f.o.b. by which stoker he anticipated being able to get good steaming results from dross coal, costing about 10s. per ton, and also to save labour in the boiler room.

Boksburg (Transvaal).—During the month of September the electric lighting department at Boksburg was administered by the Electric Lighting Co., on behalf of the municipality which took over the plant, &c., as and from September 1st. It is hoped that the change in the arrangement will be effected by January 1st next.

Johannesburg.—The Tramway and Lighting Committee has had under consideration the question of reducing the cost of electric lighting and power to consumers, and it is now proposed that a new system shall come into vogue on and from January 1st next. In his report to the Committee, the general manager suggests the following reduced charges: *Lighting.*—The charge now proposed is a flate rate of 6d. per unit. He does not recommend a system of rebates to large consumers to start with, but this might come into force later, when works costs are reduced. *Power.*—The following flat rate charges are recommended: (*a*) 4d. per unit for energy used at any time; (*b*) 3d. per unit for energy used at any time except between the hours of 5 p.m. and midnight; (*c*) for large consumers such terms as may be agreed upon between the Council and the consumers. *Minimum charges*: (*a*) For installations of 50 8-c.p. lamps, 15s. per month; (*b*) for installations of 100 8-c.p. £1 per month; (*c*) for installations of 100 8-c.p. but under 300 8-c.p., £2 per month; (*d*) for installations of 300 8-c.p., but under 500 8-c.p., £4 per month; (*e*) for installations of 500 8-c.p., but under 1,000 8-c.p., £8 per month; (*f*) for installations of 1,000 8-c.p., but under 2,000 8-c.p., £15 per month; (*g*) for installations of 2,000 8-c.p. or over, £25 per month. The Committee has approved of these charges, but also adds that there should be a minimum charge for electrical installations of 25 8-c.p. lamps of 7s. 6d. per month.

At the T.C. meeting held on October 24th, in the minutes of the Tramway and Lighting Committee it was stated that under the change-over system the Council had agreed to provide new incandescent lamps to meet the increased voltage, in place of consumers' old lamps. The stock of lamps provided for the town area was now practically exhausted, and as those supplied had not in all cases proved satisfactory, the Committee had arranged in future to pay a money allowance of 10d. per lamp in lieu of supplying new lamps. With regard to the outer area, there were still about 10,000 lamps in hand. The Committee thought, however, that consumers in this area should either be provided with lamps until the stock is exhausted or be paid a money allowance of 10d. per lamp, whichever they preferred, and it had arranged accordingly. The Committee's action was approved.

Wigan.—Mr. H. R. Hooper conducted a L.G.B. inquiry last week into an application of the Corporation to borrow £48,200 for E.L. purposes, apportioned as follows:—£20,016 for the extension of the station and the installation of new cables; £3,000 for mains for Wigan; £6,500 for mains for Ince; and £18,696 for excess expenditure. In regard to the sum for mains for the Ince area, it was explained that the Corporation has powers to purchase the Ince E.L. Order, and after some lengthy negotiations, has come to an agreement with the U.D.C. to work the order. The draft agreement now awaits the approval of the B. of T. The inquiry was adjourned *sine die*, for information not then available to be obtained.

Worsley.—The U.D.C. has empowered the Finance Committee to engage an expert to advise it respecting the proposed transfer of the E.L. Order.

Yeovil.—The B. of T. has asked the T.C. what steps are to be taken towards carrying out the E.L. Order, 1903, before considering the question of revocation.

TRAMWAY and RAILWAY NOTES.

London.—L.C.C.—At Tuesday's meeting of the L.C.C., another long debate took place on the question of tramways and street improvements, consequent upon the presentation of the adjourned joint report of the Finance, Highways and Improvement Committees. The report, to which reference was made in the last issue of this journal, submitted three recommendations. The first proposed that the Improvements Committee, when submitting a scheme for a street improvement along an existing or proposed tramway route, should report (1) whether the improvement was desirable and urgently needed apart from any question of constructing or reconstructing tramways along the thoroughfare; or (2) whether the improvement, though desirable, could be postponed for a few years except for the reason that it was required for the purpose of a tramway; or (3) whether the improvement was not required except for the purposes of a tramway. It was recommended that in each case falling under the No. 1 class no charge should be made against the tramways account; that in each case coming under No. 2 class, a contribution of a fixed sum, being one-eighth of the estimated net cost of the improvement, should be charged to the tramways account; that in each case falling under No. 3 class, the whole cost of the improvement should be charged to the tramways account, and that the recommendations of the Committee should provide for such charges against the tramways account. As an amendment, Capt. Swinton moved that the recommendation should be referred back to the Committee, on the ground that the proposal was an attempt to deceive the public. Mr. Whitaker Thompson seconded the amendment. During the discussion it was revealed that the ardent advocates of County Council tramways desired the latter to be entirely relieved of the cost of street improvements undertaken for the needs of tramways. Eventually the amendment was rejected by 72 votes to 32, being a majority of 40 against it. The original recommendation was then agreed to. It was also resolved to request the General Purposes Committee to submit such amendments of the standing orders as might be necessary to give effect to the foregoing proposals, and to instruct the Improvements Committee to bring up further recommendations with regard to the charges to be made against the tramways account in respect of the cost of improvements for which powers were obtained in the London County Council (Tramways and Improvements) Act, 1906.

The Council postponed the consideration of a report by the Highways Committee in reference to the proposed reconstruction of the tramways from (1) Highbury Railway Station *via* Holloway Road, to the Archway Tavern; (2) High Street, Shoreditch, *via* Hackney Road, to Cambridge Road; (3) Old Street, *via* City Road, to the Angel, at Islington; and (4) from the borough boundary near Coborn Road, *via* Bow Road, to the county boundary at Bow Bridge. The length of the first three lines, which are proposed for the conduit system, is 8¼ miles of single track, and that of the fourth line, which is intended for the overhead trolley system, is 1½ miles, also reckoned as single track. It is estimated that the total expenditure, exclusive of the cost of rails, will amount to £20,000 for roadwork, bridge improvements, and provisisn of cars. The cost of the rails is computed at £20,500, although it is intended to invite tenders for about 6,200 tons of track and slot rails, conductor tees, fastenings, &c., for about 20 miles of single line, at an estimated outlay of £45,000. It is proposed to enter into a temporary arrangement with the West Ham Corporation for working the Bow route on the trolley system. A further expenditure of £7,525 is suggested for alterations to the bridge carrying Hampstead Road over the London and North-Western Railway so as to expedite the work of constructing tramways on the conduit method along that thoroughfare.

Fulham.—The Highways Committee of the L.C.C. has informed the B.C. that it is hoped the construction of the authorised tramways from Hammersmith Broadway to Lower Richmond Road, Putney, will be commenced at an early date.

St. Pancras.—We understand that instead of allowing a term of 42 years in which to repay loans advanced for E.L. plant, as hitherto, the Finance Committee of the L.C.C. has intimated to the B.C. its intention to lend only for terms representing the estimated life of the various parts of the undertaking. These terms have been approved by the Electricity Committee.

L.C.C.—An extension to Highbury Corner to the Aldwych-Islington tramway was opened on the 16th inst.

South America.—Monte Video.—The United Electric Tramways have been successfully inaugurated this week. The system will comprise some 80 miles, of which 40 have been opened for traffic. Messrs. J. G. White & Co. were the contractors.

Taunton.—The Taunton Electric Traction Co. is applying to the B. of T. for powers to construct additional electric tramways in the town.

(*Continued on page* 836.)

THE ELECTRICAL EQUIPMENT OF A MODERN CEMENT WORKS.

Of the many industrial applications of electric motors, there is probably none where the power demands are more exacting or the operating conditions more severe than in cement works, by reason of the heavy starting torque required, the nature of the load handled, the constant presence of dust, and the inflammability of pulverised coal.

The plant of the Bath Portland Cement Co., at Bath, Pa., which is the subject of this article, is an example of how these conditions are met by modern electrical machinery.

This plant was designed for an output of 2,500 barrels of cement per day, and is a typical example of modern practice in the American industry. The buildings are compactly situated on four acres of ground, and are constructed of concrete and steel. The company owns 320 acres of ground, with an almost unlimited supply of cement rock, carrying approximately the correct proportions of material for Portland cement.

A general view of the buildings is given in fig. 1. The power house is built 10 ft. above the ground level, the lower part being used as a basement,

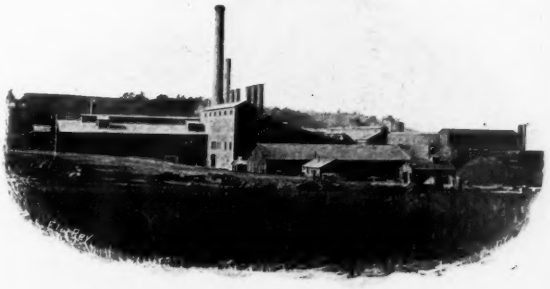


Fig. 1.—The Bath Cement Co.'s Works, Bath, U.S.A.

Fig. 2.—Interior of the Boiler House, Showing Berry Boilers.

An interior view of the boiler room is given in fig. 2, where there are eight 300-H.P. Berry boilers for a W.P. of 150 lb. per sq. in., each 10 ft. 6¼ in. in outside diameter and 20 ft. 9½ in. high, to which the bituminous coal which is used, is delivered through inclined coal chutes. The boilers at the present time are hand fired, but are arranged for automatic stokers. A brick stack 175 ft. high is placed centrally in the building, with four boilers on each side. Two horizontal duplex feed-pumps supply water to the boilers through a 2,000-H.P. open-type feed-water heater.

A reservoir having a capacity of 3,500,000 gals. is used as a reserve for water supply during the season of the year when the creek, which furnishes the usual supply, is low. Water for condensing purposes is drawn from the reservoir and is returned through a circulatory system before again entering the condenser suction pipes. The water supply for the reservoir, apart from the natural drainage of the surrounding ground, is drawn from an artesian well

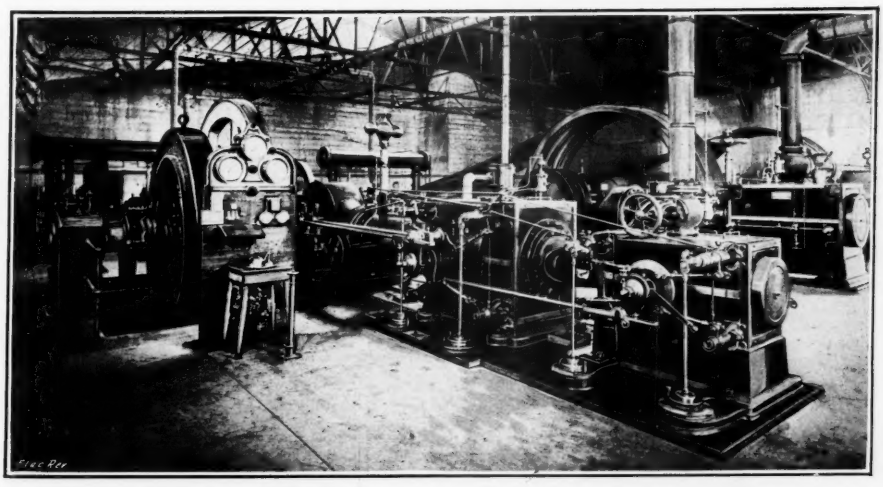


Fig. 3.—The Power Plant; a Three-phase Generator in the Foreground.

which contains steam and air pipes, cables, overflow conduits from condensers and a receiving tunnel from the reservoir.

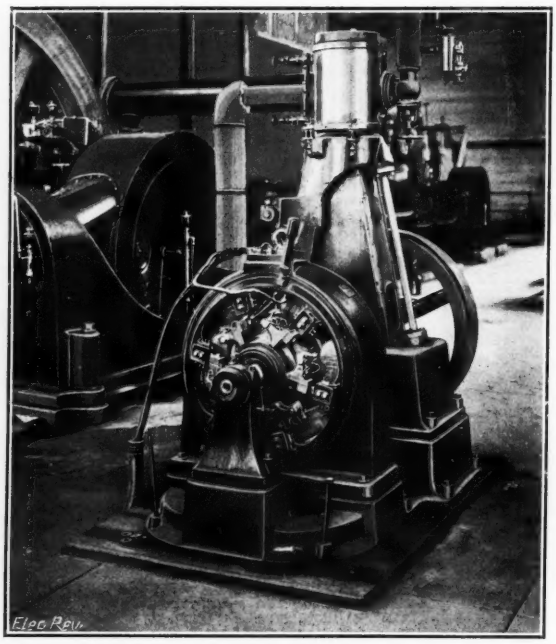


FIG. 4.—STEAM-DRIVEN LIGHTING PLANT.

300 ft. deep, by a Deming pump operated by a 25-H.P. Westinghouse induction motor.

The engine and generator equipment consists of a 350-H.P. Wetherell-Corliss tandem-compound condensing engine, direct connected to a Westinghouse 200-KW. three-phase, 60-cycle, 440-volt generator, operating at 120 R.P.M., and two 1,100-H.P. cross-compound engines of the same make, which are employed to drive the raw mill and the clinker departments. These engines are of the heavy-duty Corliss type, and drive 22 2-in. transmission ropes connected to grooved wheels on the main line shaft. To this line shaft are belted two Westinghouse 180-KW., 440-volt, three-phase, 60-cycle generators operating at 514 R.P.M. Fig. 3 illustrates the engine room.

A small lighting set consisting of a Westinghouse 10-KW. direct-current, 125-volt generator, direct-connected to a Reeves vertical engine operating at 400 R.P.M., is illustrated in fig. 4. A Westinghouse motor-generator set, used for excitation, consists of a 15-H.P. induction motor, direct-coupled to a 10-KW., 125-volt generator with a speed of 1,120 R.P.M.

The main switchboard, illustrated in fig. 5, consists of marble panels mounted upon ornamental iron legs, with a Westinghouse standard equipment of instruments for three-phase alternating-current circuits. Immediately behind the switchboard are two 20-KW. oil-insulated, self-cooled transformers with a secondary voltage of 120, which furnish current for 48 arc lamps and 1,500 16-C.P. incandescent lamps.

In order that some idea of the manufacture of cement and the possible applications of electric motors in such industries may be gained, mention is here made of the various processes employed in this industry.

In the first instance, vertical holes are drilled into the solid rock, by pneumatic drills, blasting charges being placed in the holes and ignited by electricity; this loosens the rock, which is conveyed to the mill in cars by gravitation, and dumped into two No. 6 Austin gyratory crushers, where it is reduced to pass a $2\frac{1}{2}$-in. mesh. The empty cars then run to the foot of an incline, where an endless chain, driven by a 10-H.P. induction motor, draws them to the top, and they return to the quarry by gravity. The cars have each a capacity of four tons, and on the average 17 cars per hour are hauled up the incline.

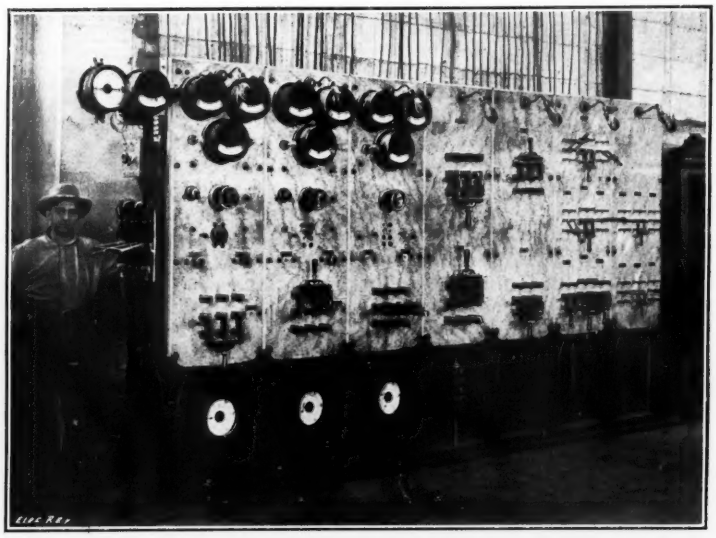
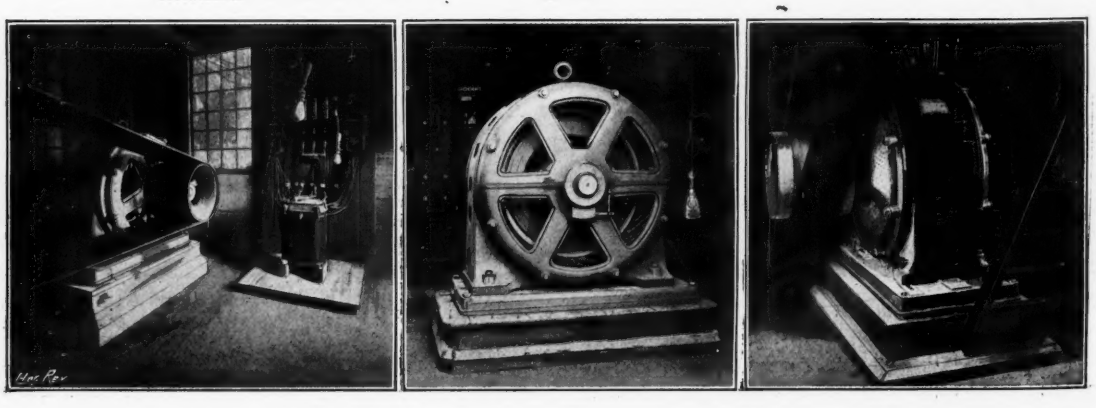


FIG. 5.—MAIN 3-PHASE SWITCHBOARD.

From each crusher the rock is delivered to a continuous bucket elevator, which raises it to a small hopper feeding two large Buchanan crushing rolls where the rock is further reduced to pass $\frac{3}{4}$-in. mesh and under; the material is then carried on a bucket elevator, which empties into two revolving stone dryers, 72 in. diameter and



FIGS. 6, 7 AND 8.—TYPES OF WESTINGHOUSE MOTOR DRIVES.

55 ft. long, each divided into four compartments, where the stone is dried. An exhauster is used in connection with the dryers, the stack being on the outside of the building. From the dryers the material is elevated and delivered into another set of Buchanan rolls driven by a 100-H.P. motor, fig. 6; and again elevated and delivered into a storage bin in the store house or to a reversible belt conveyor, travelling over the top of the storage bin which feeds the raw mill, delivering material to a belt conveyor discharging into 17 storage hoppers above the grinding mills. The storage bin in the store house is of concrete and steel construction, and has a capacity of 1,200 tons of crushed stone. A system of conveyors and elevators enables the hoppers in the raw mill to be fed from this point also. The large storage bin in the storehouse is kept filled to its maximum capacity, as this department only operates 10 hours per day, and enough excess material is stored to enable it to close down for three days at least. The machinery in this department is operated by an engine drive through shafting.

The next process is taken up in the raw grinding room, where 16 Fuller-Lehigh mills are driven through shafting and clutches, as in the case of the stone house. Here the material is fed from the hoppers through the mills into a screw conveyor, in a tunnel beside the mill foundation, which empties into an elevator in the kiln house. In the latter the machinery is driven by a line shaft belted to a 100-H.P. Westinghouse induction motor operating at 580 R.P.M. This motor also drives a supplementary 22-KW. exciter.

The kiln house, a view in which is shown in fig. 11, connects with part of the raw grinding room, and the rotary kilns are placed transversely across the building. There are six kilns, each 100 ft. long, 7 ft. 6 in. dia. at the large end and 5 ft. 6 in. at the other end, which leads in each case to a chimney 60 ft. high and 5 ft. dia. Each kiln is driven from the line shaft by means of a speed regulator of the interlocking-cone pattern, controlled by a tight and loose pulley, which also controls the feeding of the raw material from the storage bins, which have a capacity of 200 tons each.

The raw material is raised by an elevator from the raw mill to a screw conveyor, travelling transversely across the kiln storage bins. A similar conveyor also removes the spill and dust from the dust-chambers at the feed end of the kilns and returns it into the elevator that receives material from the raw mill. At the delivery end of the kiln the clinker discharges through a chute into a bucket elevator—one elevator being used for two kilns—which in turn discharges into one of three clinker coolers, 10 ft. diameter and 40 ft. high, illustrated in fig. 10. The elevators are operated by a 30-H.P. induction motor. From the coolers the clinker is conveyed to a store of 100,000 barrels capacity, where the material is well seasoned before grinding.

The fuel for the kilns consists of pulverised coal, which is forced through pipes from the feeders to burners, as shown in figs. 9 and 11. The feeders, six in number, are each operated by a 1-H.P. induction motor.

The clinker is automatically measured before storing and is subsequently fed to three pot-crushers; an automatic gypsum measuring device ensures that a continuous flow of this ingredient enters and mixes with the clinker before

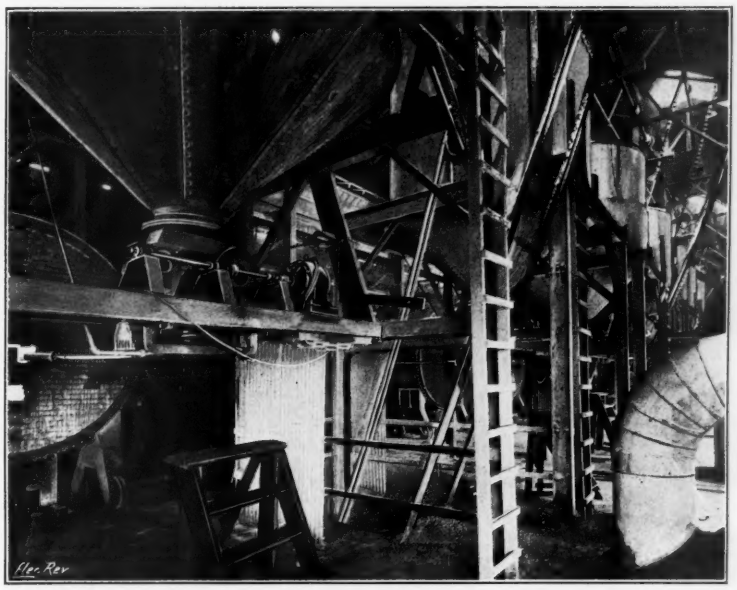


Fig. 9.—Coal Feeders (for Kilns), Electrically-driven.

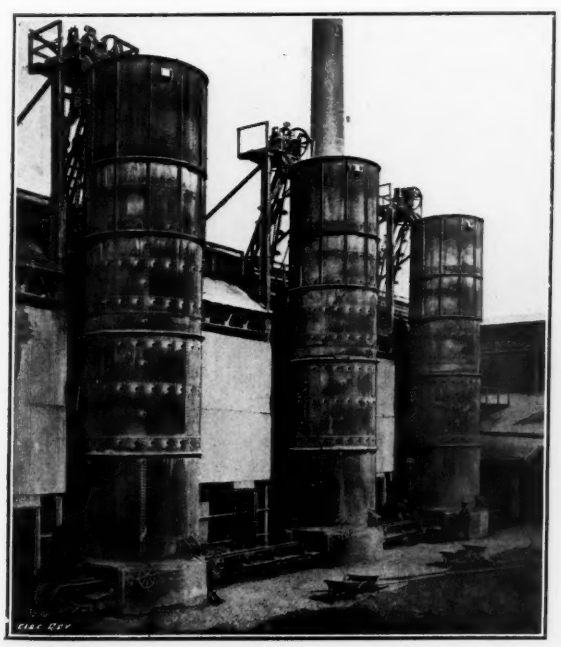


Fig. 10.—Clinker Coolers with Electrically-driven Bucket Elevators.

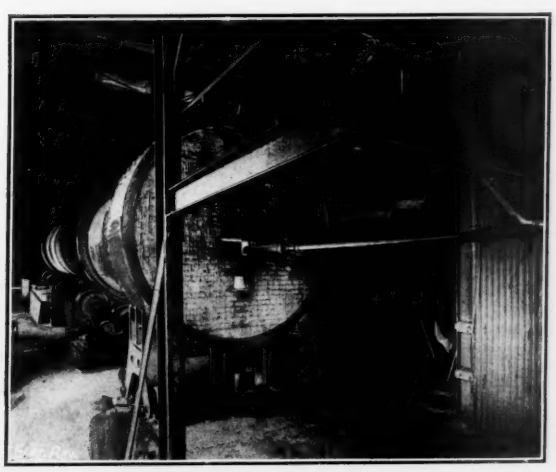
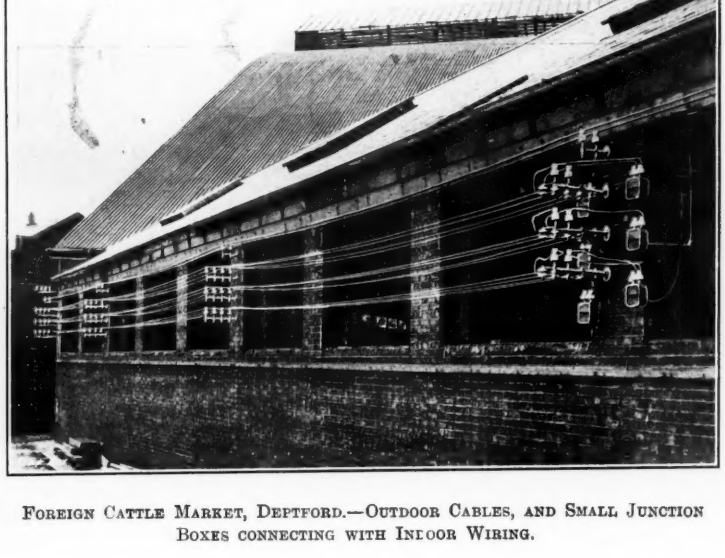


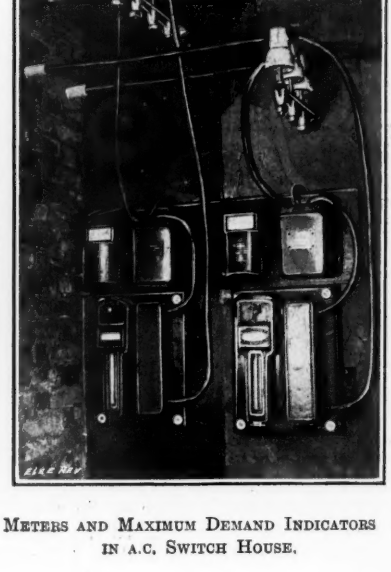
Fig. 11.—Electrically-driven Rotary Kilns.

crushing. From the pot-crushers the clinker is conveyed to two sets of grinding rolls which reduce it to the size of peas; it then passes to a clinker-grinding room containing 24 Griffin mills, where it is ground to cement. After the clinker-grinding room comes the cement stock house, where the finished product is stored. From the latter department, cement screws discharge the material into a large bin on one side of the building and into a number of smaller bins on the opposite side, from which, again, screw conveyors deliver it to the packing house which has a capacity of 4,000 barrels per day. All the machinery in the stock and packing house is operated by a 100-H.P. Westinghouse induction motor, illustrated in fig. 8.

The coal pulverising plant, where the coal for the kilns is prepared, contains one self-contained coal dryer, a Mosser crushing roll, and four Lehigh-Fuller mills for pulverising

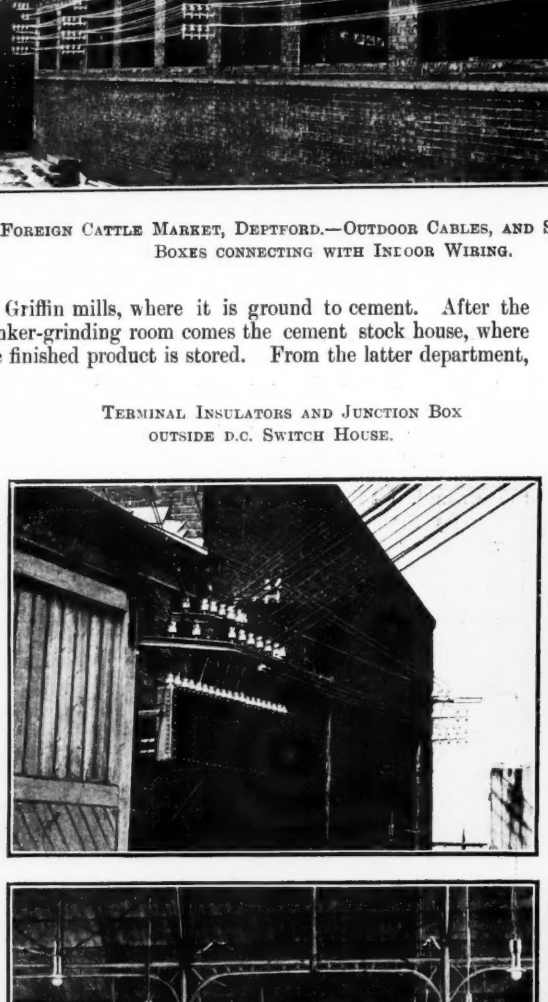


Foreign Cattle Market, Deptford.—Outdoor Cables, and Small Junction Boxes connecting with Indoor Wiring.

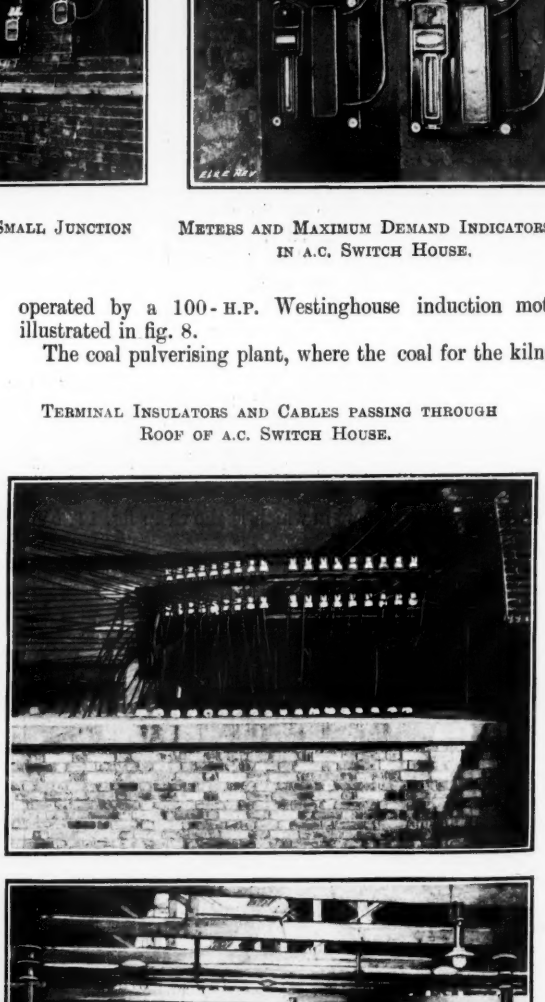


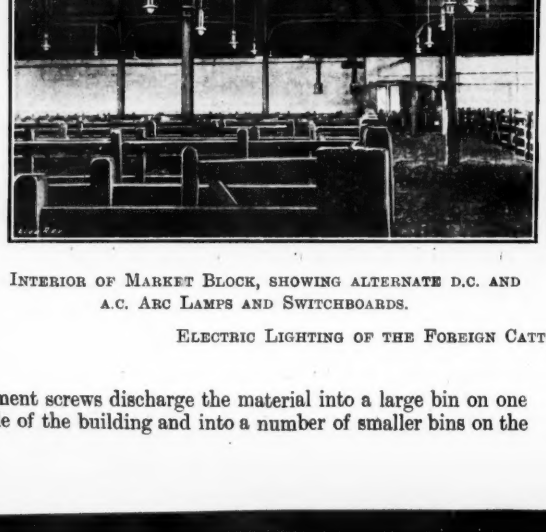
Meters and Maximum Demand Indicators in A.C. Switch House.

Terminal Insulators and Junction Box outside D.C. Switch House.

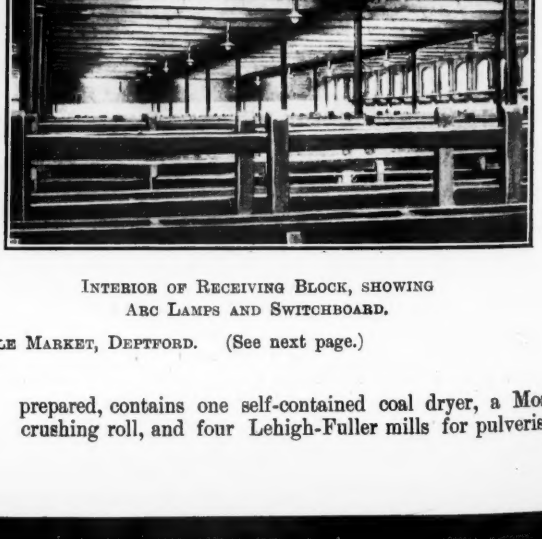


Terminal Insulators and Cables passing through Roof of A.C. Switch House.





Interior of Market Block, showing alternate D.C. and A.C. Arc Lamps and Switchboards.



Interior of Receiving Block, showing Arc Lamps and Switchboard.

Electric Lighting of the Foreign Cattle Market, Deptford. (See next page.)

the coal. After passing through the dryer, the coal is delivered by a screw conveyor into the Mosser crushing roll, from where it is conveyed to storage bins for the Lehigh-Fuller mills. From the mills the coal is delivered by means of a screw conveyor and an elevator to the coal bins in front of the kilns. All the machinery in this department is driven by a 200-H.P. induction motor, shown in fig. 7.

A modern machine shop operated by a 10-H.P. Westinghouse induction motor, where all repairs are done, completes the equipment of one of the most modern electrically-driven cement plants in the United States.

ELECTRIC LIGHTING OF THE FOREIGN CATTLE MARKET, DEPTFORD.

We recently had the pleasure of inspecting the electric lighting of the huge Cattle Market of the Corporation of the City of London, at Deptford, an installation which presents many features of interest, differing as it does to a considerable extent from the cut and dried practice generally met with nowadays. The work was carried out to the specifications and under the supervision of Mr. S. G. C. Russell, M.I.E.E., consulting engineer, by Messrs. Lund Bros. & Co., of 78, Queen Victoria Street, E.C., to whom we are indebted for facilities to visit and describe the installation.

The scheme comprises the lighting of the whole of the main market buildings and streets with arc lamps, and of the superintendents' houses and offices with incandescent lamps. Electrical energy is derived from the generating station of the London Electric Supply Corporation, which is situated near the Markets, the supply being both A.C. and D.C., and being delivered at two points.

The whole of the outdoor wiring has been carried out with overhead mains supported on insulators; the indoor wiring, on the other hand, has been executed in steel barrel in the houses and offices, and wrought-iron barrel (steam quality) in the Market Buildings and Lairages, every precaution being taken to prevent any danger of fire. The work was begun in November last year, and was completed last April; it involved the erection of over 25 miles of wire, indoor and outdoor, 212 arc lamps and 450 incandescent lamps. The accompanying illustrations (page 834) show the general character of the work, though unfortunately an installation of this kind does not lend itself very well to photographic reproduction.

The Markets cover an area of 33 acres, and, indeed, constitute a small town, in the ramifications of which it is easy to lose one's way. Within its area, besides the houses and offices of the superintending staff, there is included accommodation for no fewer than 6,000 head of cattle, and 50,000 head of sheep; there is also a range of slaughter-houses for each class of beast, these being rented by butchers from the Market Committee. Suitable storage for straw and forage is, of course, provided, and three large jetties, each capable of berthing the large trans-Atlantic steamers engaged in this trade, occupy the river frontage of the site. Thanks to his long experience, the Superintendent, Mr. G. Philcox, probably knows more about foreign cattle than any other living man.

As mentioned above, the electricity supply is of two kinds: the direct-current supply is given at 460 volts, for arc lighting only, while the alternating current is supplied at 210 volts, 83 cycles per second, for both arc and incandescent lighting. Special plant has been put down in the generating station for the D.C. supply, thus ensuring entire independence of the two sources, and the lighting throughout is so arranged that in the event of the total failure of one source, ample light would still be available from the other to carry on the work of the Market.

The whole of the arc lamps were supplied to Messrs. Lund Bros. by Messrs. Veritys, Ltd., as sub-contractors, and are of the enclosed type. The A.C. lamps are of the Aston-Worsley pattern, connected two in series on 210 volts, and taking 4 amperes. Each lamp is provided with an automatic cut-out and substitutional resistance, which prevents the extinction of the other lamp on the failure of the one to which it is attached.

The D.C. street lamps are of the same pattern, taking 4 amperes, and are connected five in series on 460 volts; the indoor D.C. lamps on the other hand are of the twin carbon enclosed type, connected two in series on 460 volts. As far as possible, the D.C. and A.C. lamps are fixed alternately inside the buildings, so that an equal distribution of the light is obtained on either system. The resistances in series with each circuit of D.C. lamps are fixed near the switch boxes, and the latter are bolted to the end walls of the sheds at a height of about 10 ft. from the ground—a measure of precaution rendered necessary by the somewhat crude and unaffected methods in favour with the drovers, to whom cast-iron is but a frail and tempting target.

The outdoor wiring has been carried out with copper cables covered with jute braiding, the latter of course being merely a protective covering; the cables are secured to the insulators with specially annealed galvanised iron wire, and are strained up tightly, both for the sake of appearance and to prevent accidental contacts. In a few cases where heavy cables have to be carried across streets with long spans, it has been thought advisable to use steel bearer wires.

As will be gathered from the illustrations, a large number of conductors often had to be dealt with in a very confined space; no conductor, bracket, or lamp was permitted below a height of 16 ft., and frequently the headroom beneath the eaves, rain-water pipes, &c., was very limited. By careful arrangement, however, all these difficulties were overcome. Perhaps the most troublesome part of the work was met with at the junctions of the indoor and outdoor wiring; watertight boxes were required at these points, and as they could not be obtained ready made, Messrs. Lund Bros. and Co. were obliged to adopt special designs, most of this work being executed on the site.

The general procedure in these cases was to construct a substantial iron box, with a shallow compartment at the top; the overhead mains were led downwards through porcelain tubes, passing through holes in the bottom of the compartment, and the latter, as well as the interior of the tubes, was afterwards filled with hot bitumen compound. The V.R.-covered cables from the interior of the building were brought in steel pipes into the lower part of the box, and there connected with the overhead conductors by mechanical couplings. This method of construction has proved thoroughly sound and watertight, and has given full satisfaction.

The outdoor lamps are mostly carried on brackets bolted to the walls of the buildings; the brackets, being of various sizes and shapes, were made of 1½-in. steam barrel bent to suit the various positions, on the spot. Most of the lamps are fixed, but a number of them are provided with lowering gear, the leads being of sufficient length to allow of the lamps being lowered for trimming without the use of automatic connections.

The direct-current switch room is situated at the centre of the Market, and provides for 76 twin-carbon and 36 single-carbon arc lamps, arranged on 18 circuits. Owing to the very confined space within which the switchboard had to be erected, it was necessary to arrange it in two tiers; this, however, has resulted in no inconvenience. The board consists of enamelled slate panels, fitted with bus-bars, from which the various circuits, each controlled by two linked switches and fuses, are led. The switches and fuses are of high-pressure type, enclosed in iron boxes.

The remaining apparatus includes a main D.P. switch and fuse and lightning arresters; a Ferranti watt-hour meter and a Reason maximum demand indicator are fixed in another room at the boundary of the site.

From this main board nine distribution boards are fed: each of these contains positive and negative slate panels fitted with linked switches and fuses, in a cast-iron box with lock-up door. As above mentioned, the twin-carbon lamps are arranged two in series on each circuit, and the single-carbon lamps five in series.

The alternating-current sub-station is equipped with two Berry transformers, made by the British Electric Transformer Co., Ltd., of 50 KW. each, transforming from 1,500 to 210 volts. The main switchboard is fixed in a separate room, and is generally similar to the D.C. board, providing for 19 circuits. There are nine distributing boards, as before; 100 arc lamps are fed from the A.C. mains, 84 being of the twin-carbon type, two in parallel, and 16 single-carbon lamps, two in series.

The largest cables used are 37/12 S.W.G., from the service point to the main D.C. switchboard; most of the others are from 7/12 to 7/16, with 7/18 leads from distribution boards, and there is a 19/14 feeder to the incandescent lamp switchboard.

The street lighting is carried out with 36 D.C. and 16 A.C. lamps, the former being run five in series on 460 volts, and the latter two in series on 210 volts; these are controlled direct from the main switchboards.

A specially high standard of workmanship and material was required for the indoor work. The iron barrel was carefully earthed everywhere, as well as the boxes, &c. All the piping used in the Market buildings and lairages was wrought-iron steam barrel, of heavy gauge, reamed and rodded, and served inside and out with two coats of Dr. Angus Smith's composition; and cast-iron drain boxes, fitted with cocks, were provided. The pipes and fittings were supplied by Messrs. Conduits and Fittings, Ltd. The insulated cables were of the Cable Makers' Association's 2,500-megohm grade, and were obtained from Messrs. Johnson & Phillips, Ltd. The bitumen used in the junction boxes was of special quality, supplied by the Standard Bitumen Co.

The whole of the work was carried out by Mr. F. C. Polden, A.M.I.E.E., A.M.I.Mech.E., a member of the firm of Messrs. Lund Bros. & Co. The clerk of works for Mr. Russell, the consulting engineer, was Mr. F. W. Rayner.

Many difficulties were met with in the execution of the contract, due to the exceptional nature of the work and to the conditions under which it had to be carried out, and great credit is due to all concerned for the success with which they were overcome.

TRAMWAY and RAILWAY NOTES.

(*Concluded from page* 830.)

Australia.—VICTORIA.—It has been arranged that the Chief Commissioner of Victorian Railways (Mr. Tait) shall submit a report at an early date on the electrification of the suburban railway lines.

The formal opening of the electric tramways of the North Melbourne Tramway and Lighting Co., which runs throughout the Essendon and Flemington districts, took place in October last. The cost of the whole undertaking is about £130,000. The engines in the power house are by Messrs. Browett, Lindley & Co., and Messrs. J. G. White & Co. were the contractors.—*Australian Mining Standard.*

WEST AUSTRALIA.—A movement is on foot to extend the Fremantle Electric Tramways to North Fremantle.

Barnsley.—The T.C. has given its formal consent to the application to Parliament by the Barnsley, Wombwell and Wath Tramways Co., for powers to construct tramways in the borough. The Council, however, reserves full right to oppose the Bill on preamble and to insert such clauses as are necessary to protect the rights of the borough.

Consent on similar conditions has been given by Wombwell U.D.C.

Ceylon.—The *Ceylon Observer* says that the Colombo Gas and Water Works Co. contemplates putting down an electric tramway between Kandy and Peradeniya.

Continental Notes.—SPAIN.—The horse tramway between Miranda and Santander is to be converted into an electric line.

PORTUGAL.—The Union of electric tramway employés of Lisbon has decided in favour of a general strike.

Lancashire.—The Lancashire United Tramways Co. is negotiating with the Salford Corporation for the laying of about 200 yards of track in Newtown, which would connect with the Corporation's system.

Lancaster.—At the seventeenth annual meeting of the Lancaster and District Tramways Co. which paid a dividend of 2½ per cent. to ordinary shareholders, and of 5 per cent. to the preference shareholders, a discussion took place on the electrification of the line from Lancaster to Morecambe. Councillor A. Bell, the chairman, said that if they could electrify it, they could run it at 6d. per mile, against 12½d., and on the present traffic this would yield a profit of £3,846. Assuming that the cost of electrification would be £100,000, this would be a return of 3¾ per cent., but with increased traffic they might do better. It was, however, considered that nothing could be done until the Corporation changed its policy.

Maidstone.—The T.C. has decided to apply to the Light Railway Commissioners for authority to construct a line of tramways from Mill Street, Maidstone, to the village of Tovil. The T.C. has also agreed to double the existing line along the High Street to the existing double route at the foot of the bridge over the Medway.

South Africa.—DURBAN.—The Tramways Committee has reported on the question of 1d. fares over short distances, but as it seemed likely to be unremunerative, it was resolved that the existing fares be not altered at the present juncture.

Wood Green.—For nearly a month the work of laying the electric tram lines at the Wood Green end of the Wood Green to Enfield route was at a standstill, but on Monday last week the men resumed work. The cause of the delay was, it is said, that the Middlesex C.C. engineer contended that the rails were not in accordance with specifications. The differences have now been satisfactorily settled.

York.—A Press correspondent states that notices have been given that an application is to be made in the ensuing session of Parliament for the construction of electric tramways in York and suburbs on the "G. B." surface contact system. We are informed that it is believed that the Corporation will approve of the application.

TELEGRAPH and TELEPHONE NOTES.

Australia.—According to official returns, the total capital cost of the telephone exchange system throughout the Commonwealth is £1,428,000. In 1905 the revenue was £323,322 and the expenses £171,497, leaving a balance of £151,825 to cover interest and depreciation. It is expected that £50,000 per annum will be expended during the next five years on new instruments and switchboards in Melbourne, in connection with the adoption of the toll rate. An entirely new exchange is to be installed in the Melbourne General Post Office on the central battery system, with a capacity of 10,000 lines.

Buenos Ayres.—The Stockholm Telephone Co. has applied to the Buenos Ayres Municipality for a concession for a new telephone service on the central battery system. There are already two telephone companies at work in Buenos Ayres.—*Review of the River Plate.*

Newcastle-upon-Tyne Telephones.—On Wednesday last week, Mr. Stuart Jones, an Inspector of the General Post Office, London, held an inquiry into a number of complaints against the telegraph service in Newcastle. The chief grounds of complaint were the inattention of the operators and the insufficient number of the trunk wires.

Overhead Telegraph Wires.—The opposition of the Borough Councils to overhead wires continues, and on Monday Mr. Hopkins sat as arbitrator in a dispute between the Postmaster-General and the Lambeth B.C. on this subject. The hearing was adjourned.

Portable Telephone.—It is stated that Mr. F. Medhurst, of the Tasmanian Telegraph Department, has devised a new portable telephone and telegraph instrument for military use, weighing only 3 lb., and of very high efficiency.

Switzerland.—There was a considerable increase in traffic of the telephone and telegraph services during 1905, and in consequence the financial results are very satisfactory. The receipts and expenses for 1904 were respectively 10,022,389 and 10,705,536 fr. (£400,895 and £428,221 about), leaving a deficit of 683,146 fr. (£27,326), while the same figures for the year under review were 11,303,151 and 10,887,151 fr. (£452,126 and £435,486), leaving a balance to the good of 415,999 fr. (£16,639), thus making the improvement on 1904, 1,099,146 fr. (£43,966). The balance on the working of 1905 has been written off capital expenditure, which amounts to 31,775,007 fr. (£1,271,000). The total amount spent in new constructions was 2,837,651 fr. (£113,506). The increase in traffic was chiefly due to inland messages, of which there were 1,576,154, being an increase of 67,580, or 4·48 per cent. over the results of 1904. International traffic amounted to 2,159,785 telegrams, being 183,024, or 9·26 per cent. in excess of 1904. Transit traffic also exceeded the previous year's record by 94,428 telegrams or 12·41 per cent., the total being 854,937. The total traffic increase was, therefore, 345,032 telegrams, or 8·126 per cent., their value being put at 258,252 fr. (£10,330).

The telephones were also more extensively used than in 1904, the number of conversations being 36,470,475, an increase of 3,238,124 for 1905. The Revenue derived from the telephonic service was 3,900,663 fr. (£156,026), or an increase of 360,676 fr. (£14,427) over 1904. The number of subscribers increased by 3,019, to 50,333.

The telegraphic system was less in 1905 then 1904 by 135 kilometres of line, the total mileage being 6,034 kilometres. The reason for this diminution is that some offices were closed, and some wires were used for the telephone service. The wire mileage was 22,860 kilometres, an increase of 289 kilometres. The system also possessed 117·9 kilometres of cable line, with 3,249 kilometres of wire, being respectively an increase of ·5 and 106 kilometres. Trials with the Hughes duplex system on the Bale-Milan line did not give satisfactory results, by reason of the varied line construction on Swiss soil, being partly aerial and partly

underground line, and it has been, therefore, decided to adopt the Baudot system.

The 366 systems of the telephone service have a total length of 16,318 kilometres of line and 252,235 of wire, an increase of 627 kilometres of line and 10,107 of wire over 1904. During 1905 the Baudot system was installed on the Berne-Paris telegraphs and the Hughes-Duplex on the line between Zurich-Frankfort-on-the Main. The telephone circuits between Geneva and Montreux, and Bellinzone and Faido were also adapted to telegraphic correspondence by means of the Cailho system. The Zurich-Lucerne line was duplexed, and the telephone circuits between Basle-Strasburg and Strasburg-Frankfort o/M-Berlin were also temporarily used for telegraphic correspondence between Basle and Berlin. 40 new offices were opened and 13 closed during the year, there being 2,261 telegraph and 693 telephone stations.

The employés in both services numbered 4,037.

Of the International telegrams, 703,444 were sent to and received from Germany; 575,831 are claimed by France; 253,283 by Italy; 163,366 by Austria; 158,793 by Great Britain; 76,285 by Russia. Gibraltar and Malta come at the end of the European list with 709. 50,483 were exchanged with North America; 7,964 with India; and 10,135 with Egypt. Service telegrams numbered 177,724, 57·7 per cent. being on account of the postal service, and 42·3 on account of the telegraph service. The average number of words per telegram was 12·26.

The total number of telephonic conversations was 36,803,415, being an increase over 1904 of 3,292,896; of the conversations, 126,012 were between Switzerland and Germany, France coming next with 78,747, and Italy with 27,315.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1.)	Aug. 26, 1901	
Trinidad-Demerara (No. 2.)	Nov. 18, 1906	
Cayenne-Pinheiro	Aug. 18, 1904	
St. Lucia-Martinique	May 7, 1902	
Dominica-Martinique	May 7, 1902	
Guadeloupe-Martinique	Aug. 29, 1906	
Mole St. Nicholas-Port au Prince	Aug. 16, 1906	
Curacao-Coro / Curacao-La Guayra / Curacao-Maracaibo	Closed.. Jan. 12, 1906	
Reissa-Issa and Reissa-Yemani (Yemen)	Oct. 22, 1902	
Tarifa-Tangier	Jan. 18, 1904	
Port Arthur-Chifu (Closed)	Mar. 9, 1904	
Garachico-Santa Cruz	July 12, 1906	
Las Palmas-Arecife	Aug. 18, 1906	
Landlines.		
Puerto-Barrios	Aug. 28, 1902	

Wireless Telegraphy.—The Hamburg firm of B. Blumenfeld have had one of their coal steamers equipped with wireless telegraph apparatus on the De Forest system, for the purpose of enabling the vessel to be worked more advantageously. This is the first German coal steamer which has been provided with a wireless installation. The advantages of the system lie in the fact that the steamer is placed in the position of being able to announce her arrival at the English coaling port, or to intimate on the return journey the approach of the vessel towards the North Sea station at Borkum, hours before the actual appearance of the vessel. By this means it is possible, by arrangements made in the meantime, at once to begin the loading or discharging of the steamer on her arrival. The steamer performs the journey from Cuxhaven to Newcastle-on-Tyne in 30 hours, the loading with 2,500 tons of coal occupies 12 hours, and the discharge of the cargo at Hamburg 10 hours. Consequently the steamer is able to take in two cargoes weekly, as compared with one in the case of the other vessels in the service.

A message has been received at Nauen from the steamer *Cap Ortegal*, in the Bay of Biscay, at a distance of over 1,300 miles.

It is stated that the American patent rights of the Poulsen system of wireless telegraphy have been sold to Lord Armstrong and Mr. Sigurd Bojessen, of London, for £100,000. The purchase money is to be paid at latest in September, 1907.

It is reported that Mr. Marconi has been approached to install a powerful wireless telegraph station at the Vatican for the purpose of enabling the Pope to communicate with the outside world, thus practically ensuring the independence of the Pontiff of any Power in his communications with his followers.

CONTRACTS OPEN and CLOSED.

OPEN.

Accrington.—November 30th. Cables, troughing, bitumen; pole-work, overhead work, switch-pillars; electric tramcars complete, for the Corporation tramways. See "Official Notices" November 9th.

Cape Town.—November 28th. Tenders will be received by the Chairman of the Tender Board, Cape Town, for the supply of dry cells, oblong, 3 in. by 1¾ in. by 6 in. high, regenerative or non-regenerative type, for the period February 1st to October 31st, 1907.—*Board of Trade Journal.*

Great North of Scotland Railway.—December 3rd. Tenders for electric lighting material. Forms from Stores Superintendent, Aberdeen.

Heston-Isleworth.—Cable, troughing, tiles, pitch, &c., for the U.D.C. See "Official Notices" to-day.

North-Eastern Railway.—December 1st. Telegraph stores. Forms of application from Mr. C. H. Ellison, York. Sealed tenders, endorsed, to the Secretary, York, by 9 a.m. on date mentioned.

Powell Duffryn Steam Coal Co., Ltd.—December 3rd. Tenders for electric fittings. Forms from Stores Manager, Aberaman Offices, Aberdare. Tenders to company's London office.

Rome.—December 31st. The Municipal Council is inviting tenders for new street railways at Rome. Apply to the "Sindaco di Roma."

Saltburn-by-the-Sea.—Storage battery for the Cleveland Trust, Ltd. See "Official Notices" November 16th.

Spain.—December 3rd. The municipal authorities of Navalmanzano (province of Segovia) are inviting tenders until December 3rd for the concession for the electric lighting of the town during a period of 18 years. Particulars from, and tenders to, El Secretario del Ayuntamiento de Navalmanzano (Segovia).

Spain.—December 6th. The *Gaceta de Madrid* of November 8th contains a notice inviting tenders, which will be opened 30 days from the above mentioned date, at the office of the Director-General of Posts and Telegraphs, Madrid, for laying a submarine cable between Barcelona and Palma (Majorca), in accordance with conditions and specifications set forth in the *Gaceta*. Payment will be made by the Spanish Government in the form of a certain number of annual payments of 81,551 pesetas (about £2,939); if the amount of cable required is that estimated, viz., 156 miles, these payments will be made for not more than 13 years—13 payments. If this estimate should prove incorrect, payments will be made for a greater or lesser number of years, according to the amount required. The work will be awarded to the tenderer requiring the least number of annual payments, provided that the conditions of tender are fully complied with. A copy of the *Gaceta* can be seen at the offices of the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall Street, London, E.C., and details may be obtained from the Direccion-General de Correos y Telégrafos, Calle de Carretas No. 10, at Madrid.

Sunderland.—November 30th. Four 350-KW. rotary converters, static transformers, and high-tension switchgear for the same. See "Official Notices" November 16th.

CLOSED.

Beckenham.—The U.D.C. has accepted the tender of Messrs. Matthews & Yates, London, for the supply of an electrically-driven fan for use as an induced draught apparatus, at £389.

Birmingham and Midland Tramways.—The Joint Committee has placed orders with the Brush Electrical Engineering Co., Ltd., for the overhead line equipment of the Tipton section of the South Staffs. tramways, and of the College Road and Stratford Road section of the City of Birmingham tramways; also for a 1,000-KW. turbo-alternator for Smethwick power station.

Chesterfield.—The Corporation has ordered two tramcars, mounted on radial trucks, from the Brush Electrical Engineering Co., Ltd.

Dartford.—The U.D.C. has accepted the tender of Messrs. S. W. Gibson & Co. for wiring the Baptist Church for the electric light.

Hastings.—The T.C. has accepted the tender of Messrs. Willans & Robinson, Ltd., for the supply of a steam turbo-alternator and condensing plant.

India.—Contracts for an electrical installation for Lucknow Industrial schools, and for the workshops of the Bari Doab Irrigation Canal, Punjaub, have been placed with the Brush Electrical Engineering Co., Ltd., Loughborough.

London.—PADDINGTON.—The B.C. on Tuesday dealt with the following tenders for a telephonic intercommunication installation at the Town Hall and new extension:—C. Mickleburg (accepted at £217 10s. first cost, and £10 10s. per annum for maintenance, upon the "common return wire throughout" principle), secret service system, *i.e.*, return wire to each circuit, instruments recommended by contractor, first cost £275, annual

maintenance £10 10s.; common return wire throughout, or common earth return, instruments in accordance with official specification, first cost £250, annual maintenance £10 10s.; instruments recommended by contractor, first cost £217 10s, annual maintenance £10 10s.; alternative, first cost £225, annual maintenance £10 10s.

The following tenders were received for a telephone exchange installation at the Town Hall and extension:—National Telephone Co. (accepted at £62 12s.), unlimited service, £62 12s., message rate £44 12s. Post Office Telephone Service, unlimited service, £88 5s., message rate £58 5s.

L.C.C.—The Highways Committee of the L.C.C. recently invited tenders from selected firms for the supply of four new 500-KW. motor-generators required for sub-stations at Battersea, Brixton, Clapham and Streatham. The following offers have been received:—

British Westinghouse Co.	(recommended)	£7,588
Dick, Kerr & Co.		8,677

Stratford-on-Avon.—The D.P. Battery Co., Ltd., Bakewell, have secured the contract for 220 300-ampere-hour cells for Stratford-on-Avon.

Swindon.—The T.C. has accepted the tender of the Brush Electrical Engineering Co. for the supply of three tramcars, and that of Messrs. Davey, Paxman & Co. for a new generating set.

Swinton and Pendlebury.—The U.D.C. has accepted the following tenders in connection with the establishment of E.L. works:—

J. Gerrard & Sons, Ltd., Swinton.—Sub-station buildings, £797.
Mr. Bertram Thomas, Manchester.—Switchboard instruments and connections, £238.
Callender's Cable & Construction Co., Ltd.—Mains, £5,960.
Ferranti, Ltd., Hollinwood.—Meters, £221.

Worcester.—The T.C. has accepted the tender of the Electric Construction Co., Wolverhampton, for the supply of additional plant, at £4,134.

FORTHCOMING EVENTS.

To-day's Events (Friday, November 23rd).—At 5 p.m. Physical Society, Royal College of Science. Prof. J. A. Fleming on "The Electrical Radiation from Bent Antennæ." Dr. R. S. Willows on "The Electrical Resistance of Alloys."

Saturday, November 24th.—Northampton Institute Engineering Society. Visit to the City and South London Railway.
Institution of Electrical Engineers (Manchester Students). Visit to the Stuart Street Generating Station.
Tuesday, November 27th.—At 8 p.m. Institution of Civil Engineers. Mr. E. P. Hill on "The Yield of Catchment Areas."
Wednesday, November 28th.—At 8 p.m. Society of Arts. Mr. J. W. Gordon on "Patent Law Reform." Sir Wm. H. Preece will preside
At 8 p.m. Institution of Civil Engineers. Students' visit to the G.N., Piccadilly and Brompton Railway.
Friday, November 30th.—At 7.30 p.m. Institution of Electrical Engineers (Manchester Students). Mr. L. H. A. Carr on "Trolley *v.* Conduit."
At 8 p.m. Institution of Mechanical Engineers. Discussion on Mr. T. Clarkson's paper "Steam as a Motive Power for Public Service Vehicles."
Northampton Institute Engineering Society. Mr. F. A. Thompson on "Switchboards and Switchgear."
At 8 p.m. Institution of Civil Engineers (Students). Mr. P. A. Spalding on "Applications of Electricity in Printing Works." Sir Alex. Kennedy will preside.
Junior Institution of Engineers. Visit to the Great Northern, Piccadilly and Brompton Railway.
Saturday, December 1st.—Institution of Electrical Engineers (Manchester Students). Visit to the Lancashire Power Co.'s generating station.

THE ELECTRICAL ENGINEERS R.E. (VOLS.).

THE following orders are issued:—

Monday, November 26th.—"A" Company, recruits' infantry drill, 6 p.m.; technical drill, 7 p.m.
Tuesday, November 27th.—"B" Company, technical drill, 6 p.m.
Thursday, November 29th.—"C" Company, technical drill, 6 p.m.
Friday, November 30th.—"D" Company, technical drill, 6 p.m.

The strength of the Corps has been reduced, therefore there is at present no further need for recruits.

J. H. S. PHILLIPS, Captain E.E.,
For O.C.E.E.R.E. (V.).

NOTES.

Smoking Concert at Aberdeen.—A very successful smoker—the first of its kind—was held on the 13th inst., by the employés of the Corporation electricity department. About 250 were present at the function, which was held in the Queen's Rooms, the latter being attractively decorated with coloured electric lamps. Mr. J. A. Bell, the borough electrical engineer, occupied the chair, and during the course of the evening, congratulated Sir Alexander Lyon, the Lord Provost, who was present, on his recently acquired knighthood.

Gas Fatalities.—A leaky gas main in a cellar was responsible for the death of an old man named Alfred Gill, at Bradford, last week. Although he was suffocated in his own house, curiously enough, gas was not used by him.

A serious gas explosion, which did some £40 worth of damage, and occasioned personal injuries, occurred at Sunderland on the 12th inst., through a leaky fitting.

Several families occupying rooms in one of the huge blocks of London County Council tenements off Drury Lane had a narrow escape from asphyxiation on Sunday morning, when it was found that four rooms on the ground floor were filled with gas. The occupants were lying on their beds in an unconscious condition. The service pipe running from the main under the concrete courtyard was leaking badly, and the gas had percolated through the brickwork of the tenements and then into the rooms on the ground floor.

Municipal Finance at Woolwich.—An interesting sidelight is thrown on Woolwich finance under the late Labour *régime* by a letter from the manager of the London and Provincial Bank, which the Council recently considered. The borough treasurer had been instructed to arrange an overdraft not exceeding £60,000, and the manager, in agreeing, intimated that the rate of interest must be raised from 3 to 4 per cent. The letter continued:—"The reason for this is that the account since the arrangement in January, 1904, has for some time past been kept quite differently from what it used to be, and what it was expected to be when the arrangement was come to, for instead of being usually in credit, as formerly, with only occasional temporary advances for revenue purposes, it has become a permanently debit account, caused apparently by the Council overdrawing for capital expenditure, instead of borrowing money from the London County Council." The Finance Committee recommended that the proposed increase in the rate of interest be approved, and that the bank be informed that the whole question will be reconsidered by the Council.

At the same meeting the Council decided to apply to the L.C.C. for a loan of £5,645, the excess capital expenditure incurred one year and eight months ago, viz., March 31st, 1905, on electricity account.

Canals and Waterways.—The Royal Commission has continued its sittings at Westminster, and recently learnt that the Post Office found the canals very useful for obtaining access to large towns with overhead telegraph and telephone lines! By this means the Department was able to bring the telephone trunk lines within four miles of the London Central Exchange. It is satisfactory to know that the canals have some value to electrical men.

Fire Risks.—In connection with the destruction of Selby Abbey, the Society for the Protection of Ancient Buildings states that it ought to be an inviolable rule with organ builders that their workmen, when tuning organs or otherwise attending to them, should only use electric torches. Beyond this no new heating apparatus ought to be used except on special authority.

Institution Notes and Lectures.—JUNIOR INSTITUTION OF ENGINEERS.—Under arrangements kindly made by Mr. A. L. C. Fell, M.I.E.E., Chief Officer of the L.C.C. Tramways, a visit to the Council's Electricity Generating Station at Greenwich was paid by this Institution on November 17th, and was numerously attended. The Superintendent, Mr. E. W. Dickinson, and members of the staff showed the visitors round in parties.

PHYSICAL SOCIETY.—At the meeting held November 9th, 1906, Prof. J. Perry, F.R.S., President, in the chair, Mr. G. F. C. Searle gave an exhibition and description of apparatus for students' practical work in Physics.

LEEDS UNIVERSITY ENGINEERING SOCIETY.—At a recent meeting of this Society, Mr. D. R. MacLachlan, B.Sc., A.M.Inst.C.E., contributed a paper on "Heat Non-conducting Coverings for Steam Pipes." He gave results of experiments which showed that the colour of the finish put on coverings exercised no influence on the heat emitted, but that a bright metallic surface reduced the heat loss; also that for coverings of the same class and area the temperature of the surface gave an indication of the heat loss. He then showed that from the result of any one experiment on the heat loss from a covered pipe, the heat emitted from any diameter of pipe covered with varying thickness of covering could be calculated, and hence that for the same quantity of heat emitted per sq. ft. of bare pipe surface, a greater thickness was required on the pipes of smaller diameter. There was a certain thickness of covering with which the maximum economy could be effected. Various coverings were shown and their composition and characteristics pointed out.

P. & O. BATTI-WALLAH'S SOCIETY.—In our last issue we stated that a smoking concert was held on Wednesday last week at the Holborn Restaurant. We regret that a misunderstanding arose as to the date of the concert. It was held on Wednesday this week, the 21st inst.

INSTITUTION OF ELECTRICAL ENGINEERS (GLASGOW).—A meeting of the Glasgow Section was held on the 13th inst. Mr. W. W. Lackie, vice-chairman, who presided, expressed regret that Lord Kelvin was prevented from being present and delivering a presidential address. It was now certain that Lord Kelvin would be present at the annual dinner of the Glasgow Section of the Institution on November 27th, and he hoped the members would support the officials in their endeavour to make the function a success. A paper written by Prof. F. G. Baily and Mr. W. S. H. Cleghorne B.Sc., Carnegie research student, was read and discussed.

Institution of Electrical Engineers (Leeds).—At the December meeting of this Section Mr. G. A. Lister will read a paper on "The Heating of Magnet Coils."

Institution of Electrical Engineers (Glasgow Students).—A meeting of the Students' Section was held on the 16th inst., in the Technical College, Glasgow, when Mr. Archibald R. Low, M.A., read a paper on "General Principles of Direct-current Design, with Critical Points Therein."

Cleveland Institution of Engineers.—At a recent meeting of this Society, at Middlesbrough, Mr. J. H. Harrison, the new president, delivered an address, in the course of which he referred to the waste of surplus gas from blast furnaces and coke ovens in the district. He thought the local ironmasters should combine to put down electric generating plant at various points to utilise the gas, thus obtaining a supply of electric power throughout the district at an exceedingly low price. We have for years past urged this proposition on the attention of the iron industries, and we cannot understand why they are so blind to their own interests as to delay action in the matter.

Electrical Schemes for the 1907 Parliamentary Session.—Notices of the following applications in regard to electric light, power and traction schemes for the coming 1907 Session of Parliament, are contained in the *London Gazette*, and in the daily Press.

Huddersfield Corporation Tramways.—Extension of tramways.

Grimsby Electric Lighting.—Extension of Corporation supply.

Audenshaw U.D. Tramways.—Revival and extension of U.D.C.'s 1899 order.

Minehead and Dunster Electric Lighting.—Provisional order for electric lighting in Minehead and district.

Electric Supply Corporation, Ltd.—Transfer to above of undertakings and orders relating to Exmouth, Hitchin, Sidmouth, Stevenage, Dawlish, Hendon, Teignmouth, Chelmsford and Totnes, &c.

Worsley, Whitefield, Kearsley and Tyldesley-with-Shakerley Electric Lighting.—Application by Lancashire Electric Power Co. for provisional order to supply above districts.

Brighouse Electric Lighting.—Further provisions relating to Corporation electricity supply.

Grays and Tilbury Gas.—Supply of electrical energy.

King's Norton and Northfield U.D.C.—Reconstruction of tramways and electrification of same.

Lower Thames Tunnel Railways.—New railway and provision for electrification of same.

Westhoughton, Hindley, Abram and Aspull Electric Lighting.—Application by Lancashire Electric Power Co. for provisional order to supply above districts.

Carnarvon Lighting.—Agreement between Corporation and National Electric Construction Co., Ltd., and further powers for supply.

Channel Tunnel Railway.—Powers for electrification.

West Ham Corporation Tramways.—Additional electric tramways in the borough.

Haslingden, Rawtenstall, Bacup and Ramsbottom Electric Lighting.—Application by Lancashire Electric Power Co. for a provisional order to supply in above areas.

Burnham (Somerset) and District Electric Lighting.—Provisional order for the area, by a new company.

London United Tramways.—Construction of subway and works at Hammersmith Broadway, &c.

Leicestershire and Warwickshire Electric Power Co.—Extension of time; provision for overhead transmission.

London and North-Western Railway.—Powers for electrical working.

London United Tramways.—Various works and powers.

The following applications, which will be dealt with at length in a later issue, are also announced:—

London County Council.—To generate and supply electrical energy in the County of London and portions of the counties of Essex, Kent, Surrey and Middlesex; purchase or transfer to Council of undertakings and powers of authorised distributors; transfer of powers of purchase of local authorities; powers to Council and authorised distributors to supply machinery and fittings, &c.

London Electric Supply.—Constitution of Joint Committee of London Electric Supply Companies; amalgamation of undertakings; provision for joint supply in areas; agreements with power companies.

North Metropolitan Electric Power Supply Co.—Extension of powers of company; transferring and leasing undertakings of local authorities and companies; supply to railways, &c.

Administrative County of London and District Electric Power Co.—To incorporate a company to enter into agreements with the L.C.C., with a view either to undertaking a partial supply in the London area, or to lease from the L.C.C. the whole undertaking during the initial stages.

London and District Power.—A company to generate and supply electricity in the administrative county of London and in parts of the counties of Essex, Kent and Surrey.

Watford and Edgware Railway.—Extension of time for completion, and agreements with other electric railway companies.

The Scottish Central Electric Power Co. intends to apply for a provisional order for power to supply electricity to and within the parishes of Falkirk, Larbert, Grangemouth, Denny, Dumpace, Kilsyth and Glamannan, except such part of any of the parishes as lies within the burgh of Falkirk, Denny and Dumpace, or the burgh of Grangemouth; and also to and within the parish of Cambernauld.

Threatened Strikes.—Last week a large meeting of workers in engineering and allied industries was held at Birmingham, and it was resolved to commence a campaign for an advance in wages.

As a result of an exhaustive inquiry into the alleged grievances of four conductors of the Belfast Tramway, who had been dismissed for alleged offences, the Corporation has refused to reinstate three of them, and the fourth man has been reinstated conditionally. The men, prior to the inquiry, threatened to come out on strike if the four men were not reinstated. So far, no action has been taken.

The Clyde strike has resulted in a victory for the employers.

Explosion in Telephone Boxes.—On Monday last several of the National Telephone Co.'s boxes in Crossbank Street, Oldham, were blown up by gas which had accumulated therein. No one was hurt.

Appointments Vacant.—Engineer (£100) for Kildare Electric Lighting Committee, applications by November 24th; district mains superintendent for Manchester, at £150 per annum. See our advertisement pages to-day.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the Electrical Review *posted as to their movements.*

Central Station Engineers.—A grand smoking concert was held at the White Lion Hotel, Houghton-le-Spring, on Tuesday last week, on the occasion of the marriage of the resident engineer of the Durham Collieries Electric Power Co., Mr. G. A. K. Johnston. The chair was taken by the chief engineer, Mr. C. W. Nicholl, who presented to Mr. Johnston, on behalf of the staff and employés of the Power Co., a handsome silver salad bowl, a spirit tantalus and a set of silver carvers. Mr. Johnston made an effective speech, in which he advised his colleagues to follow his example, and a very pleasant entertainment followed.

Mr. J. W. Foster, of Fleetwood, has been appointed junior assistant engineer in the City of Birmingham electricity works.

Mr. J. Milton, assistant electrical engineer at Southend-on-Sea, has resigned his post.

General.—The Cardiff staff of the National Telephone Co., on November 14th, presented a case of silver fish knives and forks, two silver salt-cellars, and a silver toast rack to Mr. W. J. Marsh, switchroom manager, on his departure for Bristol. The lady operators presented Mr. Marsh with a table lamp.

The many friends of Mr. G. K. B. Elphinstone (of Messrs. Elliott Bros.) will regret to learn that he is confined to bed with a severe illness. We tender our sincere sympathy.

Obituary.—A Canadian correspondent announces the death at Lansing, Mich., of Mr. W. T. Jennings, M.Inst.C.E., of Toronto. Mr. Jennings was in his 60th year, and during his professional career had been associated with the Canadian Pacific Railway and the Dominion Government, and was at one time city engineer of Toronto. He was at the time of his decease chief consulting engineer for the Nicolls-Pellatt Syndicate, in their electrical and railroad undertakings, and was consulting engineer for the Toronto and Niagara Power Co. The deceased gentleman took a deep interest in the development of electrical engineering, especially electric traction, with which he tried experiments on the Gorge and Niagara Falls Railway.

On Friday last Mr. J. R. Wigham, director of the St. Helens (I. of W.) Electric Light and Power Co., Ltd., and of the Scarborough Tramways Co., died in his 79th year.

NEW COMPANIES REGISTERED.

Collieries Electric Power Development Syndicate, Ltd. (90,729).—This company was registered on November 8th, with a capital of £10,000 in £1 shares, to promote the use of electricity for motive power, light and heat, to carry on the business of generators, storers, transmitters, distributors, controllers and workers of electricity and contractors for public and private works, &c., and to adopt an agreement with C. E. Featherstonhaugh. The first subscribers (each with one share) are:—L. R. Lewis, Crouch Hill House, Crouch End, solicitor; H. G. Rowley, 34 and 36, Gresham Street, E.C., solicitor; C. E. Featherstonhaugh, 80, Pilgrim Street, Newcastle-on-Tyne, stockbroker; C. S. V. Brown, Millburn House, Newcastle-on-Tyne, M.I.C.E.; J. G. Pritchard, 8, Montpelier Road, Peckham, S.E., clerk; G. L. Gallott, 69, Thornton Avenue, Telford Park, S.W., clerk; and F. Rowley, 34-36, Gresham Street, E.C., chartered accountant. No initial public issue. The number of directors is not to be less than two or more than seven; the subscribers are to appoint the first; qualification, £500; remuneration as fixed by the company. Registered office, 34 and 36, Gresham Street, E.C.

Plastic Compo and General Engineering Co., Ltd. (90,719).—This company was registered on November 7th, with a capital of £2,000 in £1 shares (1,880 preferred ordinary and 120 founders'), to acquire from J. Titley, J. Johnson, S. Poole, E. T. Cresswell and H. B. Hill, the rights and interests connected with an invention, secret process or recipe for the preparation, mixing and manufacture of an improved mouldable composition or concrete material applicable to electrical insulating purposes and otherwise, to develop and turn to account the same, and to carry on the business of engineers, &c. The first subscribers (each with one share) are:—J. Johnson, 44, Willenhall Road, Bilston, Staffs., brass caster; J. Titley, Princess Street, Bilston, wood turner; S. Poole, King Street, Wolverhampton, M.D.; G. Titley, Bilston Street, Wolverhampton, miller; J. A. Jordon, Beehive Works, Bilston, manufacturer; A. J. Guy, Woodville, Newhampton Road, Wolverhampton, caterer; and S. B. Payne, King Street, Wolverhampton, stockbroker. No initial public issue. The number of directors is not to be less than three or more than seven; the subscribers are to appoint the first; qualification £100.

Controls, Ltd. (90,700).—This company was registered on November 6th, with a capital of £2,000 in £1 shares, to acquire any inventions, patents, rights and concessions relating to the recording and reproduction of speech and other sounds or light by electricity or other means, to develop and turn to account the same, and to carry on the business of automatic machine manufacturers, electricians, electrical and general engineers, manufacturers of electrical novelties, motors, photographic apparatus, &c. The first subscribers (each with one share) are:—A. J. George, 19, Upper Woburn Place, W.C., manufacturer; A. J. Kendrick, 26, Endsleigh Gardens, W.C., estate agent; T. D. Macdonald, 3, Murray Place, Manor Island, Liverpool, manufacturer; D. H. J. Hartley, 3, Essex Court, Temple, E.C., barrister; H. R. Crowley, Lyceum House, East Molesey, accountant; F. White, 35, Albert Street, Regent's Park, N.W., carpenter; and W. T. Clough, 71, Lord Street, Liverpool, estate agent. No initial public issue. The number of directors is not to be less than two or more than four; the first are A. J. George and A. J. Kendrick; remuneration as fixed by the company.

Charles Lock, Ltd. (90,686).—This company was registered on November 5th, with a capital of £4,000 in £1 shares (2,000 6 per cent. cumulative preference) to take over the business of an electrical, mechanical and general engineer and agent for and dealer in motors and cycles and accessories and fuels for the same, carried on by C. Lock, at Mansfield, Notts. The first subscribers are :—W. Burkitt, Chesterfield, gentleman, 1,000 preference shares; C. Lock, Albert Street, Mansfield, motor expert and engineer, 10 ordinary shares; F. B. Wilkinson, Cavendish Lodge, Clipstone, Notts., farmer, 100 ordinary shares; J. Briggs, Sutton-in-Ashfield, Notts., hosiery manufacturer, 1 ordinary share; W. Brining, Salter Gate, Chesterfield, chartered accountant, 1 ordinary share; F. Armstrong, Mansfield, Notts., solicitor, 1 ordinary share; and E. H. A. Lewis, Bentinck Chambers, Mansfield, accountant, 1 ordinary share. No initial public issue. The number of directors is not to be less than three or more than seven; the first are W. Burkitt (chairman), C. Lock and F. B. Wilkinson; qualification of C. Lock as managing director, 300 ordinary shares; remuneration, £200 per annum; qualification of ordinary directors, £100; remuneration as fixed by the company.

Chesham Electric Light and Power Co., Ltd. (90,833).—This company was registered on November 16th, with a capital of £25,000 in £1 shares, to carry on at Chesham and eleswhere in Bucks, the business of suppliers of electricity for light, heat, motive power and otherwise, electricians, electrical and mechanical engineers, manufacturers of and dealers in apparatus, plant and fittings used in the generation, distribution, supply, accumulation or employment of electricity, &c. The first subscribers (each with one share) are:—T. O. Callender, Hamliton House, Victoria Embankment, W.C., engineer; R. Franklin, 78, Queen Victoria Street, E.C., engineer; H. G. Harrison, The Lilacs, Leatherhead, secretary; C. W. Clark, 29A, Yukon Road, Balham, S.W., clerk; E. A. Hollingsworth, 51, Linzee Road, Hornsey, N., clerk; G. F. Hedge, 15, Forthbridge Road, Clapham Common, S.W., clerk; and P. C. Whitaker, 65, Englefield Road, N., clerk. No initial public issue; the number of directors is not to be less than two or more than seven; the first are T. O. Callender and R. Franklin, and any others to be appointed by them; qualification (except first directors), 250 shares; remuneration, £50 per annum, divisible. Registered office, Chesham Electric Light and Power Station, Higham Road, Chesham.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Sir Hiram S. Maxim Captive Flying Machine Co., Ltd. (80,404).—A list of allotments filed on September 19th shows that 4,000 preferred ordinary shares have been issued to Sir Hiram S. Maxim in exchange for £4,000 debentures, a memorandum of satisfaction of which was recently filed. The nominal capital was increased from £30,000 to £34,000 by the creation of the above 4,000 preferred ordinary shares on September 6th last.

C. & A. Musker (1901), Ltd., electrical and general engineers, Liverpool (70,573).—Issue on November 1st of £6,000 4½ per cent. debentures, part of series created July 5th, 1901, to secure £50,000, charged on the company's undertaking and property, present and future, including uncalled capital. Trustees: Law Guarantee and Trust Society, Ltd., 49, Chancery Lane, W.C. Previously issued of same series, £44,000.

Northampton Electric Light and Power Co., Ltd. (28,640).—Issue on October 30th of £2,050 4 per cent. debentures, part of series created June 3rd, 1896, to secure not more than two-thirds of the paid-up capital for the time being, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £35,750.

Consolidated Supply Co., Ltd. (Electrical engineers, London). (85,838).—Issue on October 24th of £1,000 5 per cent. debentures, part of series created July 18th, 1906, to secure £15,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holders: General Seating Co., Ltd., Northampton Grove, Canonbury, N. No trustees. Previously issued of same series: £10,500.

British Electric Equipment Co., Ltd.—This company's annual return, made up to December 31st, 1905, was filed on October 19th, 1906, 14,107 shares have been taken up out of a nominal capital of £40,000 in £1 shares. £6,107 has been received, and £8,000 is considered as paid. Mortgages and charges: Nil.

F. W. Dickinson, Ltd. (Electrical engineers, Leeds) (84,249).—A 7½ per cent. debenture dated October 29th, 1906, to secure £900, charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. Holder: F. W. Dickinson, Shaftesbury Street Lane, Roundhay, Leeds.

CITY NOTES.

The Cape Electric Tramways, Ltd.

THE report of the directors, to be presented at the tenth ordinary general meeting to be held at 1, London Wall Buildings, E.C., on December 6th, 1906, at 12 noon, for the year ending June 30th, 1906, states that the profit and loss account shows, after providing for debenture interest and redemption of debentures, a net balance to credit of £5,269 7s. 3d., which, added to the balance of £481 17s. 8d., brought forward from last year, gives a total balance of £5,751 4s. 11d. From this sum the reserve fund has been credited with the amount of £4,000, and the balance, £1,751 4s. 11d., has been carried forward to the next year's account. During the year the tramways carried in Cape Town 12,377,310 passengers, earning £147,715 10s., against 15,020,503 passengers, earning £180,905 15s. 7d. during 1904-5. In Port Elizabeth during the year 3,905,536 passengers were carried, earning £42,856 15s. 5d., against 4,227,576 passengers, earning £46,708 10s. 9d. for 1904-5. The shrinkage is due to the great business depression still prevailing throughout the whole of the Cape Colony, and there are, as yet, no definite signs that an upward tendency has commenced. The lease of the Camps Bay Tramways from the Cape Town Consolidated Tramways and Land Co., Ltd., came to an end on December 31st, 1905, and was not renewed. The diminished profits for the year under review include the loss shown on the working of these tramways for the six months from July 1st to December 31st, 1905. On October 25th, 1905, an extraordinary general meeting of shareholders was held, and a resolution was passed authorising the directors to create a "B" debenture issue of £200,000, bearing 5 per cent. interest per annum, and, in accordance with that resolution, an issue of "B" debentures of £150,000 was made, in debentures of £50 each, bearing interest at 5 per cent. per annum, the issue price being £90 per cent., which was fully taken up. The arbitration between the Cape Government and the company, in regard to the amount to be paid to the company as compensation for the expropriation of the Sea Point Railway (the former property of this company), has not yet taken place, but it is anticipated that the whole business will be concluded before the end of December this year. Having regard to the serious falling off in the profits of the company, the directors have decided to forego their fees for the past year. The auditors—Messrs. Deloitte, Plender, Griffiths and Co.—have retired, and offer themselves for re-election. All the directors retire from office, and, being eligible, offer themselves for re-election.

West India and Panama Telegraph Co., Ltd.

THE fifty-ninth ordinary general meeting of the shareholders of this company was held on Wednesday, at Winchester House, Mr. W. B. Kingsford presiding.

The CHAIRMAN, in moving the adoption of the report, said that the total receipts for the half-year amounted to £36,999, as compared with £32,773 for the corresponding period last year, an increase of £4,324, which was almost entirely derived from the company's stations in the foreign islands. The expenses had been £25,680, against £23,230, an increase of £2,450. The largest item of increase was one of £1,595, caused by their having used 11½ knots more cable on repairs than in the corresponding half-year. The work of the half-year showed a credit to revenue of £36,999, less expenses £25,680, plus interest on investment (£1,772), and £1,047 brought forward from last half-year, thus making a total of £14,138 to be dealt with. The directors recommended the payment of a dividend of 8s. per share on the first preference shares, being 4s. balance of arrears to December 31st, 1905, and 4s. on account of dividend to June 30th, 1906, amounting to £13,825, and the carrying forward of the balance of £312. The shareholders would be glad to hear that in the current half-year up to the present time there had been a substantial increase in the traffic receipts. That increase was all the more encouraging because the current half-year was usually the lean half-year. In the last report reference was made to the directors having chartered the cable steamer *Cambria* to assist their own repairing steamer in overtaking the exceptionally heavy work of restoring some of the cables which were broken, they thought, by earthquakes. The cost of the charter of the *Cambria* and of the cable used by her in effecting those special repairs and renewals, amounted to £18,270, which had been charged to reserve. The directors felt that that expenditure was properly chargeable against the reserve fund, which had in past years been accumulated to meet contingencies of that nature, and they also felt that the money had been well expended in strengthening the main cables of the company. The directors would like to be in a position to increase the reserve fund, but in face of the fact that they were unable at present to keep pace with the arrears of cumulative dividends on the preference shares which were payable out of the first available profits, they had decided not to add to the reserve fund for the time being. The future of the West India Colonies seemed to be, at all events, a little brighter than it had been during the past few years, owing to a slight revival in the agricultural interest. Sugar was now fetching much better prices than it did when they last met, and there seemed to be some hope that cotton would become a staple product in the near future. At the last meeting he mentioned that there were grounds for uneasiness as to the effect on the company's well being, of certain projects which were then under the consideration by the Colonial Office, and he read to them a letter which he had sent to the Secretary of State, in which he protested against certain statements which had been made by the Governor of the Windward Islands. He was very glad to be able to tell them that the Colonial Office disassociated itself from the remarks of that official. In other respects they had done everything in their power to protect the interests of the company. They had reason to believe that their efforts had not been fruitless, and they might rest assured that the directors would continue to exercise the utmost vigilance with a view to safe guarding the property of the company, and at the same time serving the public. In conclusion, the chairman said that he hoped the shareholders would approve the action of the directors in having given instructions that special facilities should be afforded to President Roosevelt for the transmission of any telegrams he might wish to dispatch in connection with his visit to Panama.

Mr. HENRY HOLMES seconded the motion, and the report was adopted.

The Western Union Telegraph Co.

According to the annual report to June 30th last, the outstanding capital remains unchanged at $97,370,000 (£19,474,000), of which $29,394 (£5,879) belongs to and is in the treasury of the company. The receipts for the year amounted to $30,675,654 (£6,133,133), or an increase of $1,642,019 (£328,403) over the previous year. Expenses amounted to $23,605,071 (£4,721,014), being an increase of $1,759,501 (£351,900), leaving the net revenue $7,070,582 (£1,414,116). Interest on bonds amounted to $1,327,975 (£265,595) and dividends to $4,868,088 (£973,617), leaving the surplus for the year $874,519 (£174,903), which, added to the surplus to date, gives a total surplus of $16,848,728 (£3,369,745). Of the expenses, $17,191,039 (£3,438,207) were for operating and general expenses, including taxes; $1,553,287 (£310,657) were for rental of leased lines; $4,422,959 (£884,591) were for maintenance and construction of lines and $437,784 (£87,557) for equipment of offices and wires. It is stated that the large increase in the revenues for the year has warranted a continuance of the policy of making liberal appropriations from earnings for raising the standard and improving the stability and operating efficiency of the lines, thus increasing the reliability of the service and developing the traffic, which shows an increase of over 4,000,000 messages transmitted during the year. The net growth of the plant was in poles, and cables 2,735 miles; in wire, 71,590 miles, and in offices, 509. Of the total of 1,256,147 miles of wire at the close of the year 352,164 miles were of copper, and 903,983 of iron, an increase of 45,428, and 26,162 respectively. The cost of new construction was $3,292,981 (£658,596). A complaint is made that the cost of telegraph materials is steadily increasing, and that the supply is not always equal to the demand. Contracts covering 8,311 miles of railway were closed during the year.

The Amazon Telegraph Co., Ltd.

The twelfth ordinary general meeting of the shareholders of this company was held on Tuesday, at the offices, 42, Old Broad Street, Mr. George Keith presiding.

In moving the adoption of the report, the Chairman said that business in Manoas, which was their principal and terminal station from which they derived most of their traffic, had not been so prosperous during the past troubled year as during the previous 12 months. The decrease in the currency price of rubber owing to the abnormal rise of the Brazilian exchange, as well as the smaller quantity of rubber received from the acre regions of the Upper Purus and Jurua Rivers, had had a depressing effect on local trade generally, which had reacted in a measure on their business. The ordinary traffic transmitted showed a small increase in messages, but a decrease in words of about 2 per cent. The official and Press traffic, which was carried at reduced rates, had also not been so heavy. In addition to that, the gold basis upon which their rates were fixed, came into operation in April last year, and took away the advantage of the high exchange, which until then had added very considerably to the receipts of the preceding year. As a consequence, the traffic receipts had come out at £63,849, showing a decrease of £3,404, or about 5 per cent. less than last year. That decrease had practically been covered by the increase of the subsidy. The cables during the year had been exceptionally difficult to maintain, but fortunately all the repairs required were most successfully carried out, and since July last year the full subsidy had been earned. Altogether the total revenue, including the interest brought in from the temporary investment of cash in hand, amounted to £81,133, or £221 more than last year. While no advantage had been gained for the revenue by the high exchange ruling during the year, it had largely increased the local expenses. The increased repairs to the cables had also added to the expenses and other items of expenditure were heavier. On the other hand, the cable bill for the year came out less. Altogether the working expenses had amounted to £50,482; a decrease of £2,400. As mentioned in the report, the arrears of interest up to June 30th last year, on the 5 per cent. debentures, had been funded which, with the provision made for liquidating arrears of redemption to the same date, had greatly increased the yearly charges for interest and sinking fund on that issue. In addition to that, there was for the first time the full charges on the 6 per cent. debentures. After meeting those charges as well as the working expenses there remained a surplus for the year of £3,628, which reduced the revenue deficit to £74,607. During the year the forces of the river had been more than usually active, and the cables had suffered considerably, especially in the upper reaches of the river, making it necessary to lay a duplicate cable between Manoas and Amatary—a distance of some 76 miles. That was one of the worst parts of the river. The original cable broke up shortly after it was laid in 1895, and practically disappeared, defying all endeavours to repair it. It was afterwards relaid along the north bank of the river, and had since been very difficult to maintain in consequence of the rocky nature of the bottom. The new cable had been laid along a carefully selected route on the south side of the river. It was sheathed with special steel wires, and it was to be hoped that the two cables to communicate over that difficult portion of the river would now be satisfactorily maintained. As regarded the present year, the dull season, which was the most difficult season for the maintenance of cables, was now over. The cables were all working and earning the full subsidy, and the outcome of the current year depended in a great measure upon the activity of commercial business in Manoas during the rubber season which had just commenced.

Mr. C. W. Parish seconded the motion, and the report was adopted.

Geneva Tramways Co., Ltd.—Meetings of debenture-holders and shareholders of this company have been held for the purpose of considering a scheme of arrangement. The scheme of arrangement was (1) that the company should be reorganised; (2) that the 850,000 shares of £1 each, fully paid, were to be extinguished; (3) that the 114,750 income certificates should be extinguished; (4) that the 850,000 4½ per cent. debentures should be surrendered and exchanged for (*a*) 255,000 4 per cent. debentures in the new company (or 30 per cent. of the holding in the old company), and (*b*) 510,000 shares of £1 each, fully paid; (5) that the £39,692 5 per cent. third debentures should be surrendered in exchange for 30,000 shares of £1 each, fully paid, leaving a balance of 10,000 shares of £1 each unissued and to be held in reserve. At meetings held on earlier dates, the scheme was unanimously approved.

Richard Hornsby & Sons.—The profit on the past year's working amounted to £34,232, and the disposable balance £23,397. The directors recommend a further dividend on preference stock for the half-year ended September 30th, making 6 per cent. per annum; dividend on 5,545 new shares of £10 each, fully paid, from January 1st to September 30th, at the rate of 6 per cent. per annum, less income-tax; dividend at 8s. per share, free of income-tax (being 5 per cent. per annum), on ordinary shares to September 30th; placing to reserve account £5,000; and carrying forward £1,026. During the year the company has acquired the business of J. E. H. Andrew & Co., Ltd., of Stockport, makers of the "Stockport" gas engines and suction plants.

Dorman, Long & Co., Ltd.—The report for the year ended September 30th states that a profit of £176,232 was earned, and, deducting the debit balance from last year of £18,164, there remains £158,068, which it is proposed should be applied as follows:—Interest on first debenture stock, £16,000; interest on second debenture stock, £15,000; writing off expenditure *re* issue of second debenture stock, £7,040; writing off Clarance Steel Works experimental expenditure, £13,529; directors' fees for year to September 30th, £2,000; dividend of 5 per cent. per annum, payable December 7th, £62,980; writing off for depreciation, £30,000; leaving £11,520 to be carried forward. It is stated that the company is fully occupied in all departments, and the prospects for the current year are good.

Castner-Kellner Alkali Co., Ltd.—The report for the half-year ended September 30th last, states that the net profit for the past six months is £35,946, to which has to be added the amount brought forward from last account £14,548, making a total of £50,494, and after deducting debenture and other interest (£4,971) there remains an available balance of £45,523. The directors now recommend that £15,000 be appropriated to depreciation reserve, increasing that account to £130,000, that a dividend at the rate of 7 per cent. per annum be paid for the six months, leaving to be carried forward, £14,773. The new works at Wallsend-on-Tyne are now working satisfactorily.

London, Tilbury & Southend Railway.—The company is issuing £225,000 of 4 per cent. debentures for new works, including the electrical equipment of the line as far as Barking.

Scarborough Central Tramway Co.—The directors recommend a dividend of 3s. per share, free of income-tax, for the past year.

Stock Exchange Notices.—The Committee have appointed special settling days as under:—

Wednesday, December 5th.—Newcastle-upon-Tyne Electric Supply Co., Ltd.—Further issue of 12,500 ordinary shares of £5 each (issued at £2 per share premium), £2 16s. paid (£2 capital and 16s. premium), Nos. 75,001 to 87,500; and 12,500 preference shares of £5 each (issued at 10s. per share premium), £2 4s. paid (£2 capital and 4s. premium), Nos. 75,001 to 87,500.

Thursday, December 6th.—Mexico Tramways Co.—Interim bond certificates for $7,500,000 general consolidated first mortgage 50-year 5 per cent. gold bonds.

The Committee have also ordered the undermentioned securities to be quoted in the Official List:—

Lancashire United Tramways, Ltd.—£250,000 5 per cent. prior lien debenture stock.

Manx Electric Railway Co., Ltd.—22,900 5½ per cent. cumulative preference shares of £5 each, fully-paid, Nos. 301 to 21,635 and 23,436 to 25,000; and £200,000 4½ per cent. first mortgage debenture stock.

Newcastle-upon-Tyne Electric Supply Co., Ltd.—Further issue of 12,500 ordinary shares of £5 each (issued at £2 per share premium), £2 16s. paid (£2 capital and 16s. premium), No. 75,001 to 87,500; and 12,500 preference shares of £5 each (issued at 10s. per share premium), £2 4s. paid (£2 capital and 4s. premium), Nos. 75,001 to 87,500.

And are asked to allow the following to be quoted:—

City and South London Railway Co.—£150,000 5 per cent. preference stock (1903).

Llandudno and District Electric Tramway Construction Co., Ltd.—775 shares of £100 each.

City of London Electric Lighting Co.—Mr. Joseph Bevan Braithwaite has been elected chairman in place of the late Mr. George Herring, and Mr. Frederick William Reynolds deputy chairman; Mr. Frank Bailey and Mr. Joseph Cecil Bull have been elected members of the board and joint managing directors.

Central Electric Supply Co.—The company notifies that the 4 per cent. guaranteed debenture stock transfer books will be closed from November 17th to 30th, inclusive, preparatory to payment of interest due December 1st, 1906.

Joint Stock Companies Struck off the Register.—The *London Gazette* gives notice that the following companies have been struck off the Register and are dissolved:—Marylebone Electric Supply Co., Ltd.; Mazarron Electric Light Co., Ltd.; Petersen's Water-Tube Boiler Co., Ltd.; Redditch Electric Traction Co., Ltd.; and Road Traction, Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Fortnight ended.	Receipts for the fortnight. £	Receipts for the fortnight. £*	No. of wks.	Total to date. £	Total to date. £*	Route miles open.	*
Aberdeen	Nov. 14	2,513	+ 95	24	37,220	+ 2,003	14·4	..
Ayr	,, 17	349	— 5	26	9,809	+ 167	8	..
Bath	,, 14	1,375	+ 84	46	38,349	+ 6,691	13	..
Belfast	,, 16	6,590	+1,920	46	152,417	+47,750	40	+ 6½
Birkenhead	,, 18	1,947	+ 98	33	35,730	+ 906	18·5	..
Blackburn	,, 14	1,901	+ 147	33½	35,614	+ 2,292	13·6	..
Blackpool Corp.	,, 15	673	+ 57	31	47,028	+ 3,502	11·87	..
,, —Fleetw'd	,, 17	414	+ 79	20	22,864	+ 3,662	8·25	..
† ,, —Lytham	Sep. 2	825	+ 155	39	12,897	+ 1,353	7½	..
Bolton	Nov. 18	3,930	+ 314	33	71,610	+ 5,762	26	+ 1
Bournemouth	,, 14	2,614	+ 29	32½	58,403	+10,659	20·5	+ 1¾
Bradford	,, 17	8,378	+ 441	33	153,355	+ 6,462	53	+ ·7
Brighton	,, 18	1,505	— 34	33	3,196	..	9·5	..
Bristol	,, 16	9,176	— 46	..	..	..	28·5	..
Brit. Elec. Trac. Co.								
Airdrie	,, 9	439	+ 21	45	10,031	+ 792	3·65	..
Barnsley	,, 9	2 9	— 7	,,	7,344	+ 100	..	..
Barrow	,, 9	462	+ 35	,,	11,820	+ 881	5·37	..
Cavehill	,, 9	105	+ 49	,,	4,107	+ 1,848	..	..
Devonport	,, 9	856	+ 12	,,	20,866	+ 31	8·85	..
Gateshead	,, 9	1,975	+ 84	,,	43,875	+ 2,415	11·25	..
Gravesend, N'fleet	,, 9	437	+ 18	,,	11,066	+ 566	6·5	..
Greenock	,, 9	1,032	— 163	,,	30,269	+ 1,117	7·25	..
Hartlepool	,, 9	514	+ 19	,,	13,699	+ 1,637	6·72	..
Kidderminster	,, 9	181	— 10	,,	5,485	— 45	..	..
Leamington	,, 9	264	+ 17	,,	7,959	+ 2,694	3	..
Merthyr	,, 9	405	+ 41	,,	8,965	+ 399	2·9	..
‡Metropolitan	,, 9	6,149	+1,026	,,	155,466	+35,251	22	..
Middleton	,, 9	585	— 1	,,	16,033	+ 681	8·5	..
Mid. Joint Com'tee	,, 9	18,414	—1,392	,,	454,385	+14,824	..	..
Oldham — Ashton	,, 9	1,128	+ 8	,,	25,895	+ 746	9·13	..
Peterborough	,, 9	207	+ 4	,,	5,951	— 236	5·31	..
Potteries	,, 9	3,768	+ 154	,,	80,801	+ 4,111	29	..
Rothesay	,, 9	89	+ 3	,,	10,726	+ 1,603	2·75	..
Southport	,, 9	475	— 7	,,	14,730	+ 501	8·17	..
S. Metropolitan	,, 9	722	..	39	13,347	..	..	..
Swansea	,, 9	1,622	+ 80	45	38,059	+ 5,529	5·5	..
Tynemouth	,, 9	2 2	— 54	,,	11,910	+ 49	3·75	..
Weston-s-Mare	,, 7	80	+ 17	,,	7,298	+ 624	3	..
‡Worcester	,, 9	497	— 4	,,	13,006	— 784	5·75	..
Wrexham	,, 9	191	+ 16	,,	4,736	+ 172	..	..
Yorks. Wool. Dist.	,, 9	1,722	+ 232	,,	40,993	+11,424	17	..
Miscellaneous	,, 9	189	+ 64	,,	4,838	— 244	..	..
Burnley	,, 17	2,212	+ 193	45	..	..	7·5	..
Burton-on-Trent	,, 18	541	+ 3	33	10,173	— 431	10	+ 1·5
Bury	,, 11	1,796	..	32	32,364	..	10·5	..
Cardiff	,, 10	3,875	+ 140	32	68,592	+ 896	15·87	..
Carlisle	,, 17	340	+ 27	46	8,624	+ 122	..	..
† Chatham and Dist.	,, 8	649	+ 65	45	31,340	+ 1,465	12·84	+ 3·5
Cork	,, 15	796	— 20	46	22,278	— 98	9·89	..
† Croydon	,, 9	1,272	+ 131	23	35,926	+ 3,471	12	+ 1½
Darlington	,, 10	422	+ 30	32	6,924	+ 258	4·67	..
Darwen	,, 16	487	+ 30	33	8,569	+ 422	4·36	..
† Dover	,, 10	201	+ 9	32	8,911	+ 1,185	4·75	+ 1½
Dublin	,, 16	9,168	+ 222	20	108,330	+ 5,733	18·75	+ ·25
Dundee	,, 14	2,123	+ 314	24	29,501	+ 5,443	13	+ ·5
East Ham	,, 17	1,586	+ 162	33	30,830	+ 3,045	8	+ ¾
Exeter	,, 16	525	+ 195	33	10,179	+ 197	4·75	+ ·5
Glasgow	,, 17	33,767	+3,243	27	415,547	+33,864	84·25	+ 8½
Hastings	,, 16	1,209	..	..	..	..	..	..
Huddersfield	,, 17	2,809	+ 209	33	51,141	+ 4,972	28	..
Hull	,, 17	4,675	+ 462	33	77,042	+ 3,018	13	..
Ilford	,, 17	823	+ 49	33	16,527	+ 341	6·37	..
Ilkeston	,, 15	242	+ 32	33	4,578	+ 555	3·5	..
Ipswich	,, 17	709	+ 59	33	15,183	+ 95	10·5	..
Isle of Thanet	,, 17	502	— 38	46	31,082	+ 949	11	..
Kilmarnock	,, 17	289	+ 27	27	4,384	+ 64	4·25	..
† Kirkcaldy	,, 14	252	+ 57	..	..	..	7·5	..
Lan'kshire Trm. Co.	,, 15	1,724	+ 92	46	40,811	+ 6,384	12·56	+ ½
† Lancashire United	,, 14	1,093	+ 238	46	45,768	+ 6,141	37	+ 9
Leeds	,, 10	11,915	+ 992	32	204,689	+12,954	96	+ 6·5
Leicester	,, 17	4,256	+ 401	46	..	..	..	..
Leith	,, 10	986	+ 190	26	13,863	+ 5,494	6	+ 1
† Liverpool	,, 10	10,733	+ 435	45	488,831	+11,110	104	+ 1
‡ L.C.C.	,, 3	51,882	..	31	819,989	..	106¾	+55½
London United	,, 16	10,485	+1,338	46	287,584	+24,032	..	..
Lowestoft	,, 17	346	+ 55	7	1,339	+ 216	3·5	..
Manchester	,, 17	26,902	+2,659	33	462,751	+34,619	146	+21
Newcastle	,, 17	8,041	+1,366	33	135,641	+ 9,547	25·5	..
† Newport	,, 10	578	+ 31	32	20,866	+ 1,558	14·5	+ 1·5
Northampton	,, 16	771	+ 52	33	15,133	+ 479	5·5	..
Oldham	,, 18	3,434	+ 305	34	62,478	+ 6,250	29·75	..
Pontypridd	,, 17	307	+ 32	33	5,612	+ 235	3·5	..
Portsmouth	,, 17	3,034	+ 213	33	70,795	+ 696	14·5	..
Preston	,, 14	1,363	+ 176	..	..	..	10	..
Reading	,, 15	1,196	+ 56	33	21,544	+ 348	7·5	..
Rochdale	,, 17	1,821	+ 308	32	33,372	+ 7,324	20·6	..
Rotherham	,, 15	1,055	+ 83	33	16,771	+ 1,571	10	+ ·67
Salford	,, 12	8,701	+ 482	32	147,686	+ 5,624	38·9	..
Sheffield	,, 18	10,391	+ 880	34	181,072	+12,931	35·75	+ 1½
Southampton	,, 14	1,748	..	32½	33,046	+ 500	..	..
Southend-on-Sea	,, 14	546	+ 56	33	14,752	+ 935	6	..
Stockport	.. ..	..	..	..	..	..	..	..
† Sunderland	,, 19	1,262	+ 55	33	47,730	+ 2,856	10·87	..
Tyneside	,, 14	782	+ 92	46	21,036	+ 1,918	8·87	..
Walthamstow	,, 17	874	+ 186	33	20,679	..	9	..
West Ham	,, 15	4,117	+ 499	33	75,958	+16,402	14·7	+ 1·4
Wolverhampton	,, 14	1,610	+ 135	32	28,460	+ 1,496	12·5	..
Yorks. W. Riding	,, 18	2,172	+ 834	46	39,147	..	..	..
Baker St.-Waterloo	,, 17	4,220	..	20	30,835	..	3·75	..
Cen. London Rly.	,, 17	13,882	— 445	20	118,490	— 5,488	6	..
City & S. Lon. Rly.	,, 18	6,102	— 54	20	52,691	+ 2,145	6·25	..
Dublin-Lucan Rly.	,, 16	188	+ 10	20	2,605	— 17	7	..
G. N. and City Rly.	,, 17	3,826	+ 163	20	33,559	+ 2,223	3·5	..
L'pool Overh'd Rly.	,, 13	2,755	+ 67	20	29,954	— 407	6·8	..
Mersey Railway	,, 17	3,525	+ 207	20	33,702	+ 2,527	4·5	..
Metropolitan Rly.	,, 18	31,462	..	20	296,280	..	70·5	..
Met. District Rly.	,, 18	17,191	+1,131	20	152,432	+12,373	24	..
Anglo-Argentine	,, 18	33,911	+4,347	46	696,571	+81,608	43	..
§Auckland	,, 9	9,728	+ 639	42½	109,562	+ 7,387	19·24	+ ·6
§Brisbane	Oct.	11,721	+1,371	..	..	..	..	..
§Brit. Columbia Rly.	Sep.	23,551	+2,967	13	59,223	+ 8,706	..	..
Bu'n's A'r's E.T.Co.	Oct. 20	2,926	+ 402	42	67,212	+ 8,389	24	..
Bu'n's A'r's-Blgr'no	Nov. 11	8,205	+ 780	45	163,971	+ 8,459	..	..
Calcutta	,, 17	6,498	+ 517	..	..	..	..	..
§Cape Electric T. Ld.	Oct.	14,475	..	..	..	..	..	..
§Geneva	.. ..	7,971	+ 299	..	..	..	..	..
§Kalgoorlie, W.A.	,,	3,935	..	43	42,933	..	25·5	..
Madras	Nov. 15	1,007	+ 164	45	20,111	+ 2,420	10·5	+ 1½
§Lisbon	Oct.	26,375	..	..	..	..	..	..
§Mexico	Sep.	74,400	..	..	..	..	..	..
†Perth (W.A.)	Nov. 9	1,435	+ 92	45	65,258	+ 8,591	24·25	+ 6

* Compared with the corresponding period of 1905. † One week only.
‡ Includes horse, steam and other receipts. § One month.

STOCKS AND SHARES.

Tuesday Afternoon.

Business fluctuates in somewhat irregular fashion amongst Stock Exchange markets. Some few departments are decidedly busy, and others command much more attention than they have done for the past two or three months. On the whole, it may be said that the Stock Exchange is reasonably active, and were the Bank Rate but to be reduced—of which there appears little enough prospect at present—markets might go ahead in more satisfactory fashion.

As it is, a revival in Home Railway Stocks has for its base a public recognition of the fact that even a 6 per cent. Bank Rate will not last for ever. Granting this, many prices seem as though they were too low, and bargain-hunters are on the look-out for cheap stock.

In this revival electric railway stocks have not participated to any extent, with the exception of Metropolitan. The price of the latter has advanced to 63½ upon a slight improvement in the traffics. Last week, by the way, a printer quoted the stock in this column at 6, but he must have been a bear. Districts are also better at 21½.

City and South London put on a point at 43, although Central London Deferred is a similar amount down at 73½. The latter is in spite of an impression, fairly general, that the stock will get the regular 4 per cent. at the end of the year. Some of the more cautious prophets, however, place their estimates as low as 3 per cent.

Not a single change has taken place in the Electricity Supply list, so far as the Metropolitan companies are concerned. Business in the shares is very quiet, and it is noteworthy that on Monday only three transactions were recorded in the shares of these companies. There has been some demand for River Plate Electricity shares, and the 6 per cent. Preference changed hands at £1. There has also been a little doing in Kalgoorlie Electric Preferred at about 16s. 6d.

Marconi shares have fallen $\frac{1}{16}$ upon the denial of the rumours that the company is to be amalgamated with one of the United States Corporations. Rumours have been in circulation once or twice lately to the effect that some such arrangement might be effected, but the publication of the report has brought a prompt denial from the managing director of the Marconi Company. The price is now about £1.

West India and Panama Telegraph shares provide the feature in their particular department this week, having again risen sharply upon the declaration of the dividend on the first Preference shares. As we showed last week, the arrears have been cleared off to the end of 1905, and 4s. a share on account of the half-year to June 30th, 1906, will also be distributed. This has caused a brisk improvement in the four issues of the company. The Eastern group continues steady, but without noticeable change, except for ½ rise in China shares, and the Anglo-American set has quieted down considerably. There is still a lot of gambling in Anglo "A" stock, but the alteration in the price amounts to no more than ⅜ fall. Direct United States have recovered the half-crown lost last week, and so have Great Northern of Copenhagen shares. Western Telegraph shares, *ex* 5s. dividend, are only ⅛ lower at 14⅛. The only changes in the Telephone market are $\frac{1}{16}$ rise in Monte Video Ordinary, replacing the recent insignificant fall, and ⅛ fall in United River Plate Telephone to 7⅛.

Traction issues, on the whole, are steady. British Electric Traction Ordinary at 4½ have advanced another ⅜, and the market is becoming more settled. British Columbia Deferred is 2 lower at 125½ *ex* 3 per cent. dividend, and Anglo-Argentine Preference at 5⅞ have receded a trifle, though the Ordinary are better at 7¼. No change has occurred in London United Trams.

British Insulated attracted buyers after their relapse, and are ⅜ higher at 6⅞. It must also be noticed that Willans & Robinson Preference were wanted, and the price at 2¼ has added the fraction. This is the first time in many weeks, we think, that the shares have moved up. Dick, Kerr Ordinary at 1½ are slightly easier, but the manufacturing list, as a whole, is uneventfully quiet. Aron Meter Preference rose to 16s. 6d., and then fell a shilling.

Belgium.—La Société des Centrales Electriques is the name of a new company which has just been formed in Brussels with a capital of £116,000. The new undertaking, in which the Société Internationale d'Enterprises et d'Exploitation Electriques and the Compagnie Internationale d'Electricité are interested, has been organised with the object of securing the exploiting concessions for electric lighting and power undertakings.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last four years. 1902.	1903.	1904.	1905.	Closing Quotations Nov. 13th.	Closing Quotations Nov. 20th.	Business done week ended Nov. 20th, 1906. Highest	Lowest.	Rise + or Fall —
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	3½ — 3¼	3½ — 3¾	..	..	— ⅛
155,600‡	Do. do. 5 % Debs., Nos. 1 to 1,350 Red.	100	Nil	Nil	Nil	5 %	84 — 93	88 — 93	..	..	..
702,600	Anglo-American Telegraph	Stock	60/6	61s.	2½%	3½%	66 — 68	65½ — 67½	..	..	— ½
3,148,700	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5½%	6 %	109 —110	109 —110	110	108½	..
3,148,700	Do. do. do. Deferred	Stock	1/-	2s.	Nil	½%	27⅞ — 27⅞	26⅞ — 27	27½	26⅛	— ⅜
50,000	Anglo-Portuguese Tel., 5% Mort. Deb. Stock Red.	100	..	..	..	..	101 —103	101 —103	..	..	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	8 %	8 %	6⅞ — 7⅛	6⅞ — 7⅛	..	..	..
1,982,856‡	Commercial Cable Stlng. 500 year 4 % Deb. Sk. Red.	Stock	4 %	4 %	4 %	4 %	97 — 99	97 — 99	..	..	..
16,000	Cuba Telegraph	10	5½%	10 %	5 %	5 %	8¼ — 9	8¼ — 9	..	..	..
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	10 %	17 — 18	17 — 18	17½	..	..
12,981	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	4 %	3⅜ — 3⅝	3⅜ — 3⅝	..	..	..
6,000	Do. do. 10 % Cum. Pref. ..	5	10 %	10 %	10 %	10 %	9⅛ — 9⅜	9⅛ — 9⅜	..	..	..
80,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	4½%	99½—102½	99½—102½	..	..	..
50,710‡	Direct United States Cable	20	8½%	8 %	8½%	4½%	15⅝ — 15¾	15⅝ — 16	15¹⁵/₁₆	15¹³/₁₆	+ ⅛
65,500	irect W. India Cable, 4½ % Reg. Deb., 1 to 1,200, R.	100	4½%	4½%	4½%	4½%	100½—102½	100½—102½	..	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	7 %	138 —141	138 —141	140½	138½	..
2,000,000	Do. 8½ % Pref. Stock	100	8½%	8½%	8½%	8½%	70 — 72	90 — 92	91½	90½	..
1,848,772	Do. 4 % Mort. Deb. Stock Red. ..	Stock	4 %	4 %	4 %	4 %	107 —109	105¼—107½ xd	107	106½	..
800,000	Eastern Extension, Australasia, and China Tele.	10	7 %	7 %	7 %	7 %	13¼ — 13⅝	13⅜ — 13⅝	13⅝	13⅝	+ ⅛
752,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	105½—107½	105½—107½	107½	107	..
800,000	East & S. Afric. Tel., 4 % Mt. Db., 1 to 8,000, red. 1900	100	4 %	4 %	4 %	4 %	99 —101	99 —101	99¾	99½	..
200,000‡	Do. 4 % Reg. M. Debs. (Mauritius S & b.) 1 to 8,000	25	4 %	4 %	4 %	4 %	99 —101 xd	99 —101	99½	..	..
180,887	Globe Telegraph and Trust	10	£3	5½%	5½%	5½%	10⅝ — 10¾	10⅝ — 10⅞	10¾	10⅝	..
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	6 %	14⅜ — 14⅝	14⅜ — 14⅝	14¾	14⅜	..
150,000	Great Northern Telegraph, of Copenhagen ..	10	12½%	15 %	24 %	24%	85½ — 87½	86 — 88	87	..	+ ⅛
87,900	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	4½%	100½—102½	100½—102½	..	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	13 %	13 %	58½ — 60½	58½ — 60½	59⅜	58½	..
251,127	Marconi's Wireless Telegraph	1	Nil	Nil	Nil	Nil	1 — 1⅛	1 — 1⅛	20/7½	..	— 1/16
72,680	Monte Video Telephone Co., Ltd. Ord. ..	1	8 %	8 %	4 %	5 %	1 — 1⅛	1 1/16 — 1 1/16	..	..	+ 1/16
86,492	Do. do. do. 5 % Pref. ..	1	5 %	5 %	5 %	5 %	⅞ — 1	⅞ — 1	..	..	..
1,983,333	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 %	108 —110	108 —110	109½	108½	..
1,966,667	Do. do. Def. Stock	100	4½%	5 %	5 %	5 %	108 —110	108 —110	109½	108½	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	6 %	11 — 13	11 — 13	..	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 %	10½ — 12½	10½ — 12½	..	..	..
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %	5⅝ — 5⅞	5⅝ — 5⅞	5 11/16	5½	..
2,000,000	Do. do. 8½ % Deb. Stock Red. ..	Stock	8½%	8½%	8½%	8½%	98 —100	98 —100	..	..	..
1,689,598	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	101 —103	101 —103	102	..	..
179,313	Oriental Telep. and Elec. 1 to 171,604, fully paid	1	6 %	6½%	6½%	7½%	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..
50,000	Do. do. do. 6 % Cum. Pref. ..	1	6 %	6 %	6 %	6 %	1 1/16 — 1 1/16 xd	1⅛ — 1 1/16	98½	..	..
100,000	Do. do. do. 4% Red. Deb. Stock	100	..	..	..	4 %	97 — 99	97 — 99	..	..	..
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
11,889‡	Reuter's	8	5 %	5 %	5 %	5 %	7½ — 7¾	7½ — 7¾	..	..	..
60,000	Telephone Co. of Egypt, 4½ % Deb. Red.	100	..	..	..	4½%	101 —104	101 —104	..	..	..
3,201	Submarine Cables Trust	Cert.	6 %	6 %	6 %	6 %	127 —130	127 —130	..	..	..
70,000	United River Plate Telephone	5	7 %	8 %	8 %	8 %	7 — 7½	6⅞ — 7⅛	7 3/16	7 1/32	— ⅛
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	5 %	5½ — 5¾	5½ — 5¾	..	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	5 %	110 —113	110 —113	..	..	..
15,609‡	West African Telegraph, Shares	10	2 %	4 %	4½%	4 %	10 — 10½	10 — 10¾	..	..	..
80,008	W. Coast of America, 1 to 80,000 & 53,001 to 53,008	2½	Nil	Nil	Nil	Nil	3/16 — 5/16	3/16 — 5/16	..	..	..
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	4 %	4 %	4 %	4 %	100½—108½	100½—108½	..	..	..
207,980	Western Telegraph, Ltd., Nos. 1 to 207,980 ..	10	7 %	7 %	7 %	7 %	14½ — 14⅝	14 — 14½ xd	14 7/16	14 1/16	— ⅛
663,980	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	102 —105	102 —105	104¼	102¼	..
88,821	West India and Panama Telegraph	10	Nil	Nil	Nil	..	3/32 — 5/32	5/32 — 6/32	10/-	..	+ 3/32
84,563	Do. do. 6 % Cum. 1st Pref.	10	7 %*	7 %*	6 %	5 %	7⅜ — 8⅛	8 — 8½	..	..	+ ⅛
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	Nil	5 — 6	5½ — 6½	..	..	+ ½
80,000‡	Do. do. 5 % Debs., Nos. 1 to 1,800 ..	100	5 %	5 %	5 %	5 %	100—103	101 —104	..	..	+1

Including arrears.

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

270,000	Anglo-Argentine Trams, Nos. 260,008 to 510,007, and 560,008 to 580,007	5	..	..	8 %	8 %	7 — 7½	7⅛ — 7⅜	7 3/32	7⅛	+ ⅛
260,007	Do. 5½ % Cum. Prefs., 1 to 260,007 ..	5	..	5 %	5 %	5½%	5 13/16 — 6 1/16	5⅞ — 6	6	5 13/16	— 1/16
265,600	Do. Permanent, 6 % Deb. Stock, 1888	100	..	6 %	6 %	6 %	139 —142	139 —142	..	..	+1
285,100	Auckland E. Trams., 5 % 1st Mort. Deb. Stock ..	100	..	5 %	5 %	5 %	103 —105	104 —106	..	..	..
800,000	Babcock & Wilcox, 1 to 580,000	1	..	17 %	20 %	20 %	3⅞ — 4⅛	3¾ — 4⅛	80/9	79/4½	..
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	..	6 %	6 %	6 %	1 5/16 — 1 7/16	1 5/16 — 1 7/16	..	..	..
88,000	British Aluminium, Ord., 2,001 to 40,000	5	..	..	7 %	7 %	5⅜ — 5⅝	5⅜ — 5⅝	5 9/16	5 7/16	..
40,000	Do. do. 7 % Cum. Pref...	5	Nil	Nil	7 %	7 %	6⅜ — 6⅝	6¼ — 6½	6⅝	..	..
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	6 %	6 %	6¼ — 6½	6¼ — 6½	..	..	..
20,000	Do. do. 4 % Funding Certs.	5	..	..	4 %	4 %	4 — 4¼	4 — 4⅛	..	..	..
258,000	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	5 %	102 —105	101 —105	..	..	—1
300,000	Do. do. 5½ % Loch Leven Debs. ..	100	..	..	..	..	100 —103	100 —103	..	..	..
600,000	British Columbia E. Rail Def. Ord. Stock	100	..	6 %	6 %	6 %	125 —130	124 —129 xd	125½	125½	..
800,000	Do. 5 % Pref. Ord. Stock	100	..	5 %	5 %	5 %	110 —115	110 —115	..	..	..
115,000	Do. 5 % Cum. Perp. Pref. Stock	100	..	5 %	5 %	5 %	108 —111	108 —111	109½	108¾	..
240,400	Do. 4½ % 1st Mort. Debs., 1 to 6,250	40	..	4½%	4½%	4½%	102 —105	102 —105	..	..	..
220,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	..	4½%	4½%	4½%	103 —106	103 —106	..	..	..
138,801	British Electric Traction	10	8 %	6 %	6 %	3 %	3⅞ — 4⅛	4⅛ — 4⅜	91/3	82/6	+ ⅛
161,487	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	6 %	8 — 8⅜	8 — 8⅜	8⅜	8 3/16	..
1,415,423‡	Do. do. 5 % Perp. Deb. Stock ..	Stock	5 %	5 %	5 %	5 %	104 —107	104 —107	105¼	105¼	..
410,178	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	..	4½%	4½%	85 — 88 xd	85 — 88	..	..	..
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	8 %	6 — 6½	6⅜ — 6½	6½	..	+ ⅛
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %	5⅝ — 6⅛	5⅝ — 6⅛	..	..	..
500,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	4½%	102 —105	102 —105	..	..	..
212,000	British Thomson-Houston 4½ % 1st Mort. Debs. ..	100	..	4½%	4½%	4½%	94 — 98	94 — 98	..	..	..
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	..	6 %	Nil	..	1 — 1⅛	1 — 1⅛	..	..	..
1,016,253	Do. do. 4 % Mort. Deb. Stock ..	100	..	4 %	4 %	4 %	75 — 79	75 — 79	..	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	..	11/16 — 13/16	11/16 — 13/16	..	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731 ..	2	Nil	Nil	Nil	2½%	1 — 1⅛	1 — 1⅛	..	..	..
150,000	Do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	6 %	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..
125,000‡	Do. 4½ % Perp. Deb. Stock ..	Stock	4½%	4½%	4½%	4½%	96 — 98	95 — 97	..	..	—1
125,000‡	Do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	82 — 85	82 — 85	82½	..	..
100,000	Buenos Ayres & Belgrano, 1 to 100,000	5	..	8 %	4 %	3 %	3 — 3½	3 — 3½	..	..	..
40,000	Do. "A" 6 % Cum. Pref., 1 to 40,000	5	..	6 %	6 %	6 %	5⅛ — 5⅜	5⅛ — 5⅜	5⅜	..	..
27,500	Do "B" do. 1 to 27,500	5	..	6 %	6 %	6 %	4⅝ — 5⅛	4¾ — 5⅛	95/-	..	— ⅛
317,700	Do. 5 % Deb. Stock	100	..	5 %	5 %	5 %	105 —107	105 —107	..	..	..
190,000	Do. 5 % 2nd Deb. Stock	100	..	5 %	5 %	5 %	102 —105	102 —105	..	..	..
105,000	Calcutta Trams., 1 to 105,000	5	..	6 %	8 %	8 %	7⅞ — 8⅛	7⅞ — 8⅛	8 1/16	7⅞	..
32,610	Do. 105,001 to 137,610	5	..	..	..	8 %	7⅞ — 8⅛	7⅞ — 8⅛	..	..	..
29,330	Do. 5 % Cum. Pref., Nos. 1 to 29,330	..	..	..	..	..	5¼ — 5¾	5¼ — 5¾	5⅝	5½	..
950,000	Do. 4½ % 1st Deb. Stock	100	..	4½%	4½%	4½%	103 —106	103 —106	..	..	..
35,000	Callender's Cable Construction shares	5	15 %	12½%	12½%	15%	10 — 11	10 — 11	10¾	..	..
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅝ — 5⅞	6⅝ — 5⅞	5 13/32	5⅝	..
800,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	108⅝—110½	108⅝—110½	108	..	..
491,222	Cape E. Trams., 1 to 491,222	1	..	15 %	10 %	5 %	3/16 — 5/16	3/16 — 5/16	..	..	..
450,000	Castner-Kellner Alkali, 1 to 450,000	1	..	4 %	4 %	6 %	1 3/16 — 1 5/16	1 3/16 — 1 5/16	..	..	..
230,211	Do. do. 4½ % 1st Mort. Deb. Stock	100	..	4½%	4½%	4½%	97 —102	97 —102	..	..	..
1,989,698	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	4 %	83 — 85	88 — 85	84½	83⅜	..
530,316	Do. do. 4 % Pref. Stock ..	Stock	4 %	4 %	4 %	4 %	97 — 99	97 — 99	..	..	..
530,316	Do. do. Def. do.	Stock	4 %	4 %	4 %	4 %	73 — 76	72 — 75	74	..	—1
1,480,000	City and South London Railway	Stock	3½%	3½%	3½%	1½%	41 — 43	42 — 44	43¾	41½	+1
85,000	Crompton & Co., Nos. 1 to 85,000	5	5 %	2½%	2½%	2½%	1½ — 1⅞	1⅝ — 1⅞	30/-	..	..
100,000‡	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	..	5 %	5 %	5 %	5 %	95 — 98	94 — 97	..	..	—1

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § Interim dividends.
‖ And bonus of 10s. ¶ From Manchester Share List.

(Continued on next page.)

SHARE LIST OF ELECTRICAL COMPANIES.—(Continued.)

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—(continued).

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years.				Closing Quotations Nov. 13th.	Closing Quotations Nov. 20th.	Business done week ended Nov. 20th, 1906.		Rise + or Fall—
		†	1902.	1903.	1904.	1905.			Highest.	Lowest.	
260,000	Dick, Kerr & Co., 1 to 260,000	1	..	..	10 %	10 %	1 7/16 — 1 1/2	1 7/16 — 1 1/2	28/9	..	..
305,000	Do. do. 6 % Cum. Pref., 1 to 305,000	1	..	6 %	6 %	6 %	1 1/8 — 1 1/4	1 1/8 — 1 1/4	..	..	..
294,150	Do. do. 4½ % Deb. Stock	100	..	4½ %	4½ %	4½ %	103 —106	103 —106	..	..	..
60,000	Dublin United Trams. (1896), 1 to 60,000	10	..	5¾ %	6 %	6 %	14 — 15	14 — 15	..	..	..
59,987	Do. 6% Pref. between 1 and 60,000	10	..	6 %	6 %	6 %	14 — 15	14 — 15	..	..	..
99,361	Edison & Swan Utd., "A" shrs., £8 pd., 1 to 99,361	5	Nil	Nil	2½ %	4⅛ %	1½ — 1⅝	1½ — 1⅝	31/3	..	..
17,139	Do. "A" shares, 01—017,139	5	Nil	Nil	2½ %	4⅛ %	2¼ — 2⅜	2¼ — 2⅜	..	..	..
344,025‡	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	86 — 88	£6 — 88	86½	..	..
100,000‡	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	5 %	90 — 95	90 — 95	..	..	..
112,100	Electric Construction 1 to 112,100	2	6 %	4 %	Nil	Nil	3/16 — 7/16	3/16 — 7/16	..	..	..
31,890	Do. do. 7 % Cum. Pref., 1 to 31,890	2	7 %	7 %	7 %	7 %	1 7/16 — 2	1 7/16 — 2	..	..	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Stk.	Stock	4 %	4 %	4 %	4 %	83 — 86	83 — 86	..	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	5 %	9 — 9½	9 — 9½	..	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	4 %	91 — 94	91 — 94	..	..	..
78,000	Gt. N. & City Rail Pref. Ord. "A" 4 % 1 to 78,000	10	..	3 %	4 %	4 %	3½ — 3⅝	3½ — 3⅝	..	..	..
96,000	Greenwood & Batley 7 % Cum. Pref.	10	..	7 %	7 %	7 %	10½ — 10⅝	10½ — 10⅝	..	..	..
80,000	Do. do. 5 % Mort. Debs.	100	..	5 %	5 %	5 %	102 —103	102 —103	..	..	..
200,000	Henley's (W. T.), Telegraph Works, Ord.	5	20 %	15 %	15 %	15%	12 — 13	12 — 13	..	..	..
200,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	4½%	5½ — 5¾	5½ — 5¾	..	..	..
150,000	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	4½%	108 —110	108 —110	109½	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works..	10	10 %	10%	5 %	10%	17 — 18	17 — 18	17⅞	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1⅝%	1½%	Nil	1⅛ — 1⅜	1⅛ — 1⅜	..	..	+ ⅛
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	5 %	5 — 6	5 — 6	..	..	..
600,070	London United Trams (1901), 1 to 50,007	10	..	8 %	6 %	3 %	7 — 9	8 — 8½	..	..	+ ⅛
899,930	Do. do. 60,008 to 100,000 (£6 paid)	10	..	8 %	6 %	3 %	3½ — 4½	3½ — 4½	..	..	..
125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	..	5 %	5 %	5 %	8 — 9	8 — 9	8½	..	..
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	90 — 95	90 — 95	92	..	..
314,016	Metropolitan Electric Trams, Defd.	1	Ni	Nil	Nil	3 %	1/16 — 3/16	1/16 — 3/16	2/-	..	..
500,000	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	13/16 — 15/16	13/16 — 15/16	17/-	..	..
850,000	Do. 4½ % Deb. Stock Red.	100	..	..	4½%	4½%	97 —100	97 —100	..	..	..
150,000	Peebles (B.) & Co. 6 % Cum. Pref., 20,001 to 50,000	5	..	..	6 %	6 %	4⅜ — 5	4⅜ — 5	..	..	..
24,500	Potteries E. Tro., 20,001 to 40,000 & 50,001 to 54,500	10	..	5 %	5 %	4 %	6½ — 7½	6½ — 7½	..	..	..
24,500	Do. 5 % Cum. Pref., 1 to 20,000 & 40,001 to 44,500	10	..	5 %	5 %	5 %	7¼ — 8¼	7¼ — 8¼	7½	..	..
245,000	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	101 —104	98½—101½ xd	..	..	..
37,850	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	15 %	32 — 34	31½ — 33½	32½	32	..
150,000‡	Do. 4 % Deb. Bds., 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..
3,599,200	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	..	..	5 %	5 %	90 — 92	90 — 92	90⅝	..	..
540,000	Waterloo & City Railway, Ord. Stock	100	3½%	3½%	3½%	3½%	99 —102	99 —102	100	..	..
66,666	Willans & Robinson, 1 to 80,000 & 80,001 to 116,666	5	8½%	8 %	Nil	Nil	¾ — 1	¾ — 1½	20/-	18/9	+ ⅛
66,666	Do. 6 % C. P., 80,001 to 80,000 & 125,001 to 141,666	5	..	6 %	Nil	Nil	1⅞ — 2⅛	2 — 2⅛	47/6	45/7½	+ ¼
246,806	Do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	75 — 80	75 — 80	..	..	..

ELECTRICITY SUPPLY COMPANIES.

14,000	Bromley (Kent) E.L. & P., 1 to 14,000	5	..	5 %	5⅛%	4 ⅝%	5 — 5⅛	5 — 5⅛	..	..	..
50,000	Do. do. 4½ % 1st. deb. stock	100	..	4½%	4½%	4½%	99 —101	99 —101	..	..	..
29,377	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	5	8 %	10 %	10 %	10 %	8½ — 8¾	8¾ — 8¾	..	..	..
10,623	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	7 %	7⅞ — 8	7⅞ — 8	..	..	..
300,000	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	4 %	101 —104	101 —104	..	..	..
80,000	Charing Cross and Strand Electricity Supply	5	10 %	8 %	8 %	5 %	3½ — 4½	3½ — 4½	..	..	..
80,000	Do. do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	4½%	4½ — 5	4½ — 5	92/6	..	..
80,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½%	4½%	4½%	4½%	3¾ — 4¼	3¾ — 4¼	..	..	..
420,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	101 —104	101 —104	..	..	..
44,436	Chelsea Electricity Supply, Ord.	5	4½%	5½%	6 %	6 %	5½ — 5⅝	5½ — 5⅝	..	..	..
175,000‡	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	106 —109	106 —109	..	..	..
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	5 %	5 %	6 %	6 %	9½ — 10½	9½ — 10½	10	9⅝	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	6 %	11 — 12	11 — 12	11⅞	..	..
400,000‡	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	5 %	123 —126	123 —126	..	..	..
800,000	Do. 4½ % 2nd Db. Stk., Prov. Crts., all pd.	100	4½%	4½%	4½%	4½%	100 —103	100 —103	101	..	..
40,000	County of Durham Electrical Power, Ord.	2	4 %	4 %	£3 7 0	4 %	2 1/16 — 2 3/16	2 1/16 — 2 3/16	..	..	..
50,000	Do. do. do. 5 % Pref.	5	5 %	5 %	5 %	5 %	5 — 5⅛	5 — 5⅛	..	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½%	5 %	8¼ — 8⅝	8¼ — 8⅝	8½	..	..
80,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	6 %	11¼ — 11⅝	11¼ — 11¾	..	..	..
400,000‡	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	4½%	107 —110	107 —110	..	..	..
400,000	Do. do. 4½ % 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	100 —102	100 —102	101	100½	..
80,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	4 %	2⅜ — 3¼	2⅜ — 3¼	..	..	..
80,000	Do. do. 6 % Cum. Pref...	..	6 %	6 %	6 %	6 %	4¾ — 5¼	4¾ — 5¼	5	..	..
320,000	Do. do. 4½ % 1st Mort Deb. Stk	100	4½%	4½%	4½%	4½%	99 —102	99 —102	..	..	..
10,000	Folkestone, 1 to 10,000	5	..	5½%	5½%	5½%	5½ — 5⅝	5½ — 5⅝	..	..	..
10,000	Do. 5 % Cum. Pref., 1 to 10,000	5	..	..	..	5 %	4⅞ — 5⅛	4⅞ — 5⅛	..	..	..
75,000	Do. 4½ % 1st. Deb. Stock	100	..	4½%	4½%	4½%	99 —102	99 —102	..	..	..
13,000	Hove, 1 to 13,000	5	..	8½%	8½%	9 %	8 — 8½	8 — 8½	..	..	..
10,000	Do. New (£6 10s. paid)	£3	..	8½%	8½%	9 %	6½ — 7½	6½ — 6⅞	..	..	— ⅜
37,300	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	96 — 99 xd	96 — 99	..	..	..
7,300	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	96 — 99 xd	96 — 99	..	..	..
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	12½	12 %	10 %	9¾ — 10¾	9¾ — 10¾	..	..	..
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	4 %	99 —101	99 —102	..	..	+ ⅛
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	Nil	3 %	4 %	1⅜ — 2¼	1⅜ — 2¼	42/6	41/3	..
60,000	Do. do. do. 6 % Pref...	5	6 %	6 %	6 %	6 %	4½ — 5¼	4½ — 5¼	..	..	..
874,395	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	96 — 99	96 — 99	98⅝	..	..
200,000	Metropolitan Electric Supply, 1 to 100,000	5	7½%	8⅜%	10 %	10 %	7⅜ — 8⅜	7⅜ — 8⅜	8 3/16	7⅜	..
76,121	Do. 4½ % Cum. Pref. 1—71,106, £3 pd.	5	4½%	4½%	4½%	4½%	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
220,000‡	Do. 4½ % 1st Mort. Deben. Stock	..	4½%	4½%	4½%	4½%	109 —113	109 —113	..	..	..
250,000‡	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½%	3½%	3½%	3½%	95 — 97	95 — 97	..	..	..
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	4½%	98 —101	98 —101	..	..	..
75,000	Newcastle-on-Tyne, 1 to 75,000	5	..	8 %	8 %	8 %	7⅞ — 8	7⅞ — 8	..	..	..
75,000	Do. 5 % Pref., 1 to 75,000	5	..	5%	5 %	5 %	5⅝ — 6⅛	5⅝ — 6⅛	..	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	7½%	13½ — 14½	13½ — 14½	..	..	..
64,000	Do. do. 4 % 1st Mort.Deb...	100	4 %	4 %	4 %	4 %	96 — 98	96 — 98	..	..	..
18,500	Oxford, 1 to 96 and 407 to 18,810	5	..	6½%	7 %	7 %	6½ — 6⅝	6⅛ — 6⅝	..	..	..
50,000	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	98 —100	98 —100	..	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	12½%	9¾ — 10¾	9¾ — 10¾	9⅝	..	..
20,000	Do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	7 %	7 — 8	7 — 8	..	..	..
150,000‡	Do. do. 3½ % Deb. Stock Red.	100	3½%	3½%	3½%	3½%	95 — 97	95 — 97	..	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	2½%	4 %	4 %	4 %	1 — 2	1 — 2	..	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	73 — 77	73 — 77	..	..	..
65,000	South London Electricity Supply, Ord.	5	12½%	3 %	4 %	4 %	2⅜ — 3½	2⅜ — 3½	..	..	..
121,000	South Met. Elec. Lt. & Power, Ord.	1	Nil	Nil	Nil	2½%	9/16 — 11/16	9/16 — 11/16	..	..	..
117,988	Do. Do. 7 % Pref.	1	Nil	7 %	7 %	7 %	1 1/16 — 1 1/8	1 1/16 — 1 1/8	26/3	..	..
200,000	Do. Do. 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	4½%	102 —105	102 —105	..	..	..
50,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	5 %	3 — 3½	3 — 3½	..	..	..
30,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	4¼ — 4½	4¼ — 4½	86/3	..	..
90,000	Do. do. 4½ % 1st Mort. Db. Stk. Red	100	..	..	4½%	4½%	97 —100	97 —100	..	..	..
110,000	Westminster Electric Supply, Ord.	5	12 %	12½%	14 %	13 %	9½ — 10½	9½ — 10½	9⅝	9 9/16	..
29,151	Do do. 4½ % Cum. Pref. (Originally 5%—Red. to 4½ % from 31st Dec., 1905.	5	5 %	5 %	5 %	5 %	5½ — 5⅝	5½ — 5⅝	5 1/16	5⅛	..

Shares not officially quoted:—Mackay Companies, ord., 73—75. Pref. 72—74.
† Unless otherwise stated all shares are fully paid. ‖ Interim dividends.

(Bank rate of discount 6 per cent. October 19th, 1906.

DESIGN COEFFICIENTS FOR DYNAMO-ELECTRIC MACHINES.

By H. M. HOBART and A. G. ELLIS.

(*Continued from page* 738.)

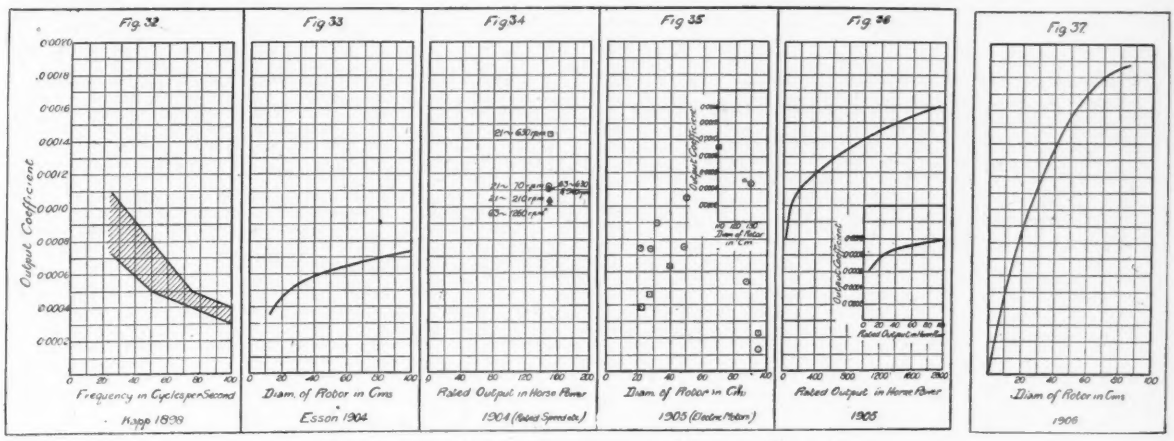
II.—The Output Coefficient of Induction Motors.

Dr. Kapp's 1898 values ("Elektromechanische Konstruktionen"), for rough preliminary induction motor designs, are as set forth in the following table :—

Periodicity.	Output coefficient.
25 cycles per second	0·00073 to 0·0011
50 " " "	0·00050 to 0·0008
75 " " "	0·00040 to 0·0005
100 " " "	0·00030 to 0·0004

These results are indicated in fig. 32. In the *Electrician* for April 1st, 1904, Mr. Esson published for the output coefficient of induction motors, the curve of fig. 33. 1905, one of the present writers put forward as a conservative basis for the design of induction motors, the curve reproduced in fig. 36. In the meantime, however, a number of his newer designs had yielded results enabling him to adopt a new output coefficient basis. It may be said that the curve in fig. 37 indicates the lines on which one should proceed in making consistent use of the "output coefficient" conception so far as relates to induction motor design. An experienced designer may often obtain values above the curve in fig. 37.

The curve of fig. 37 may be taken as referring to 500-volt designs. When designs for materially higher voltages are required, lower output coefficients must be employed. The effect of periodicity and number of poles is, however, comparatively slight. When the working out and commercial testing of induction motor designs for various speeds and periodicities and for outputs of 1,000 H.P. and upwards become matters of such everyday occurrence as to lead to the accumulation of as many data as we now have on smaller motors, it will probably be found that the output coefficient curves for motors with various numbers of poles will bear the



FIGS. 32—37.—Output Coefficient of Induction Motors.

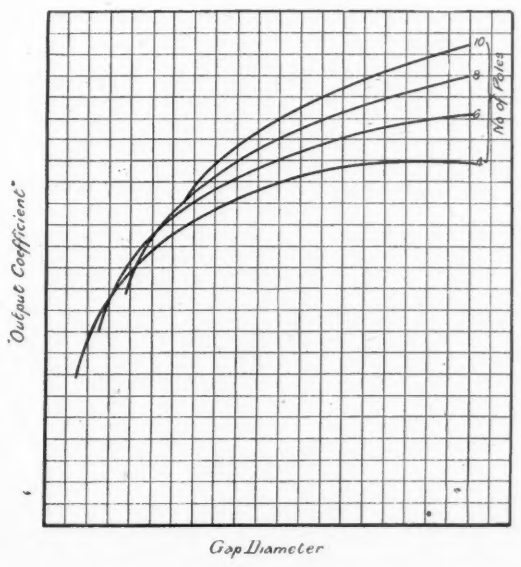


FIG. 38.

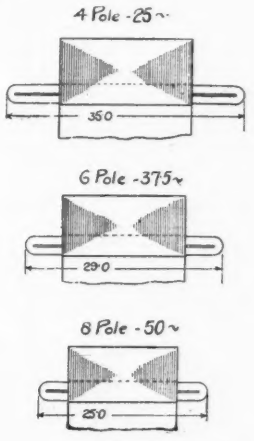


FIG. 41.

In a paper entitled "The Rated Speed of Electric Motors as Affecting the Type to be Employed" (read before the Institution of Electrical Engineers, March 10, 1904), one of the present writers contributed a number of 150-H.P. designs with the output coefficients indicated in fig. 34. In "Traction and Transmission," Vol. 10, p. 123 (1903) were brought together in a diagram the output coefficients of a number of induction motor designs by various firms. This diagram is reproduced in fig. 35 with the modification of indicating British designs with a ⊡ and Continental designs with a ⊙. In the *Electrical Magazine* for August, relation to one another approximately indicated in fig. 38. We shall also, when reaching such sizes and speeds as to encounter peripheral speed limitations, find it necessary to provide a separate group of curves of this sort for each periodicity. For motors up to a few hundred horse-power rated capacity, however, and for the customary periodicities of 25 and 50 cycles per second, the number of poles and the periodicity do not materially affect the output coefficient curve, and the values given in the curve in fig. 37 afford a good approximate basis for preliminary calculations. One must not, however, conclude from this that the cost and weight of a motor are, for a given speed, independent of the periodicity and number of poles. That this is not the case may be seen by reflecting that for a given gap diameter a four-pole design has a larger external diameter of stator punchings than a six-pole design, and the latter than an eight-pole design. Thus if, in fig. 39, the three designs

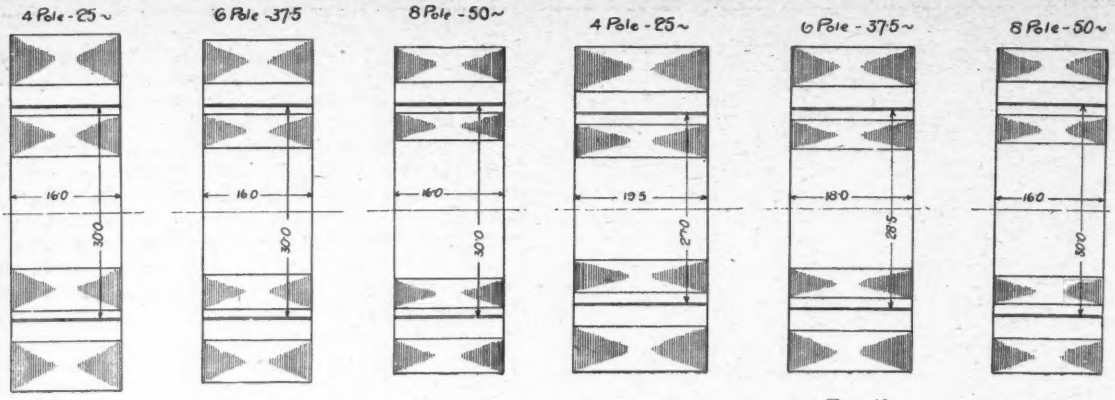


FIG. 39.

FIG. 40.

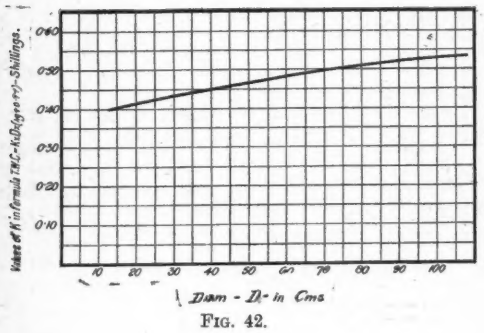


FIG. 42.

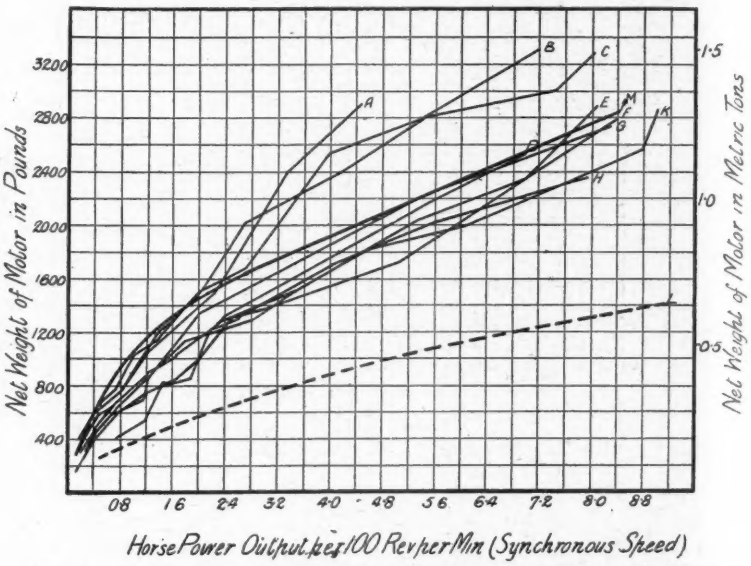


FIG. 44.—COMPARISON OF NET WEIGHTS OF THREE-PHASE 40, 50 AND 60-CYCLE INDUCTION MOTORS BY VARIOUS MAKERS.

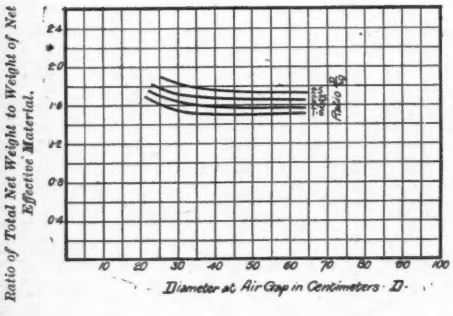


FIG. 43.—RELATION BETWEEN NET WEIGHT OF MOTOR AND WEIGHT OF EFFECTIVE MATERIAL.

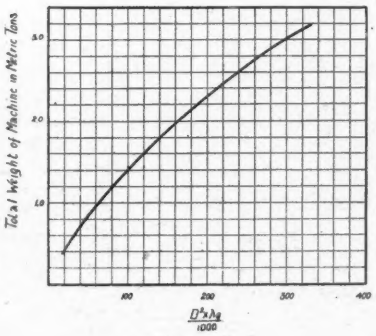


FIG. 45.

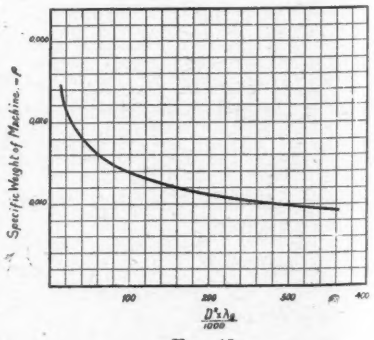


FIG. 45A.

utlined all have a gap diameter of, say, 30 centimetres, nd all have the same rated output and the same output oeff.cient, and all have a synchronous speed of 750 R.P.M., e 4, 6, and 8-pole designs being for periodicities of 25, 37·5 and 50 cycles per second, then the external diameters will be relatively proportioned somewhat as shown. A better method of designing, however, would lead to the group shown in fig. 40, in which in each case the same external stator diameter is employed, the gap diameter D being less and λg greater, the smaller the number of poles.

Thus, although $D^2 \times \lambda g$ is the same in all three cases, the weight and cost are considerably different. This becomes the more evident when we consider that not only is the core heavier the lower the number of poles, as we have seen from fig. 40, but also that the length of end connections is greater. This will be made more clear by considering fig. 41, p. 845, where we have indicated the projecting stator winding as being of the "barrel" wound or "diamond" wound type.

Although the external diameter of the stator cannot but have a considerable effect on the total works cost, the sum total of these variations appears in practice to be fairly well represented so far as relates to the total works cost, by taking this as proportional to $D \times (\lambda g + 0{\cdot}7\,\tau)$, or

$$\text{T.W.C.} = K \times D \times (\lambda g + 0{\cdot}7\,\tau).$$

K varies but slowly with increasing sizes of induction motors. For the three cases represented in fig. 41, K will have a value of some 0·6 when we express T.W.C. in shillings. Thus in these three cases we have the costs approximately as set forth in the following table :—

TABLE III.—With Constant External Diameter.

No. of poles.	Cycles per second.	Revs. per min.	Diameter. D.	Overall length of winding L = (λ g + 0·7 τ).	Relative total works cost = D × L.	Total works cost in shillings = K × D × L.
4	25	750	27	34·5	930	560
6	37·5	750	28·5	28·5	810	490
8	50	750	30	24·5	735	440

With increasing gap diameter, K slowly increases. In fig. 42 is given a curve of K in terms of the gap diameter D.

A good mechanical design is no less essential than a good electrical design. In recent best practice the relation of the total weight (exclusive of slide rails and pulley) to the weight of effective material (copper and sheet-iron) is, for squirrel-cage designs, as shown in fig. 43. Designs conforming to the relations embodied in the curves of fig. 43, and based

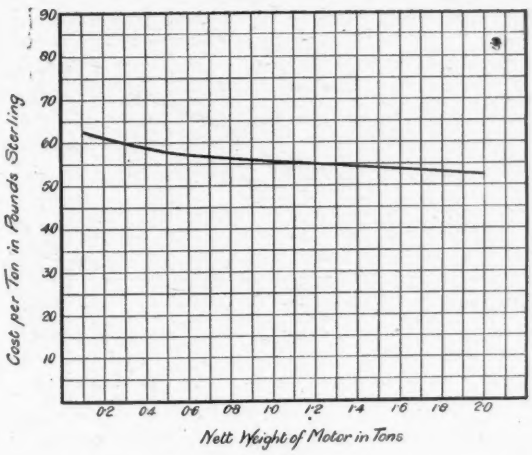


Fig. 46.

on the output coefficient curve of fig. 37, may, with careful proportioning, be built with the total weights (exclusive of slide rails and pulley) corresponding to curve L of fig. 44. The other curves on fig. 44 correspond with the designs of nine firms, and are representative of the most customary practice. A few firms, however, are adapting their products to conform with curve L of fig. 44.

In fig. 45, values for the specific weight ρ,

$$\rho = \frac{\text{Weight in tons}}{D^2 \times \lambda g},$$

are plotted as ordinates against values of $D^2 \lambda g$ as abscissæ.

From the cost coefficient curve of fig. 42 and the specific weight curve of fig. 45, we have derived the curve of fig. 46, with costs per ton as ordinates and weights in tons as abscissæ.

(*To be continued.*)

REVIEWS.

High Tension Power Transmission. Second volume. New York: The McGraw Publishing Co. Price $2.50 net.

We had the pleasure of reviewing some time ago the first volume of High Tension Power Transmission, which consisted of a series of papers and discussions presented at the meetings of the American Institute of Electrical Engineers under the auspices of the Committee on High Tension Transmission. The second volume now before us consists of a series of papers and discussions on similar subjects presented at the International Electrical Congress at St. Louis in 1904. It presents in convenient form the state of electrical power transmission at that date, the papers having been for the most part, as stated in the preface by Dr. Louis Bell, gathered from the thorny fields of practical experience. These fields have varied in kind, so have the judgments plucked from them, and the reader must not expect unanimity of opinion on any of the subjects treated, though he may learn the pros and cons of all.

The first paper is historical, and is from the pen of Mr. Chas. F. Scott. Some of the reminiscences are most interesting, and he mentions that at the Philadelphia Exhibition in 1876 there was shown a dynamo capable of supplying current for one arc lamp! He recalls that at the Electrical Congress in 1893 an engineer from California remarked: "I wish to say definitely that to the investor in California to-day the successful machine for long-distance transmission of power electrically exists only in the minds of the inventors and promoters or in some beautiful advertisement." Approximate statistics state that apparatus manufactured by the leading American companies for power transmission at 10,000 volts or higher provides for the transmission to-day of approximately 1,250,000 H.P., all by polyphase current. As illustrating the rapid progress in power work the development at Niagara Falls is cited as significant and typical. The initial installation of the Niagara Falls Power Co. consisted of three generators with a combined output of 15,000 H.P., the first power being delivered commercially 11 years ago, and now the company has generators installed aggregating over 100,000 H.P. Another company is developing 25,000 H.P. electrically, and plans are now under consideration for an additional output of nearly 50,000 H.P.

The next paper is by Mr. John S. Peck, and deals with transformers for long-distance transmission. He remarks that transformer manufacture has advanced to such a point that the design of a 60,000-volt 2,500-KW. transformer is now undertaken with far greater confidence than was felt 10 or 12 years ago in the design of a 2,000-volt unit. Practically all the transformers made in America are of the shell type, while in Europe all are of the core type. Feeling used to run pretty high between American and European designers with regard to the relative advantages of these, but now that we have had years of experience in construction, and when facility for repairs does not loom so large as in earlier days, there appears to be little difference between them. At the same time the three-phase transformer, which is largely used in Europe, and for which the core type is specially suitable, has never come into general use in America. As regards the limits of size and voltage for different classes, oil-insulated self-cooling transformers can be wound for voltages as high as desired, and up to a capacity of 500 KW. When the oil is cooled by water circulating in copper pipes coiled inside the transformer case the capacity may be increased to anything desired. Transformers cooled by a forced draught of air, or shortly, by air blast, may be of any capacity, but 33,000 volts or so is the limit of pressure for them. This latter is on account of the difficulty of eliminating static discharges over the surface of the coils, and the greatest success has been obtained with this class of transformer at pressures not exceeding 20,000 volts. The question as to whether the fire risk is greater for air-cooled or for oil-cooled transformers is discussed by Mr. Peck. He thinks that so far as actual damage to the transformer itself is concerned the risk is greater with air-blast, due to the more inflammable nature of the insulation combined with the blast and the open ducts employed in the construction of this class. Oil, he remarks, acts as an extinguisher of arcs below its surface, with which expression we are in entire disagreement. It is only in laboratories that we get this kind of effect, and when once an arc is started in a transformer case with plenty of power behind it, very soon nothing remains but bare copper, char, and stench. The majority of engineers taking part in the discussion seemed to think that the presence of large oil-cooled transformers constituted a real danger. In large stations the transformer cases contain hundreds of barrels of oil, and the greatest precautions should be taken to prevent fire spreading should anything unluckily get alight. Fortunately, in most cases of power houses being destroyed by fire, the evidence indicates that the fire originated in the neighbourhood of the transformer, and not in the transformer itself. Plenty of room for everything is the best insurance against fire risk.

The paper following is by Prof. Harold B. Smith, and deals with transformers for very high pressures. It describes experi-

mental transformers constructed at the Worcester Polytechnic Institute for pressures of 200,000 and 500,000 volts at ordinary low frequencies. The latter transformer has been in use for some years for investigation work at the Worcester Polytechnic Institute. It is situated in a house all by itself at some distance from other buildings, on account of the fire risk due to the 1,000 gallons of oil with which it is insulated.

In his paper on "High Potential Long-Distance Transmission and Control," Prof. Baum gives the results of his experience in connection with the largest transmission system in the world, that is, the system controlled by the California Gas and Water Co., which has absorbed six other companies, and has in continuous operation 700 miles of line at 50,000 volts, 70 miles at 40,000 volts, and a great many miles at 23,000, 16,000, 10,000 and 5,000 volts. The high voltage lines extend from the Sierra Nevada mountains of California to the Bay of San Francisco, and are thus exposed to all sorts and conditions of weather. In a short time some of these lines will be working at 60,000 volts. The longest distance to which power is regularly transmitted is 200 miles, most of the power being transmitted 150 miles. The Bay Counties Power Co.'s plant, which now forms part of the above system, is described in a subsequent paper by Mr. L. M. Hancock, with much interesting detail as to the hydraulic works and as to the organisation necessary for the satisfactory working of long lines. Prof. Baum gives in his paper methods of calculating capacity current, reactance pressure, rise of pressure due to changing current, regulation and electric surges. He shows that the opening of an accidental short in the line produces the condition of greatest strain on the insulation, and demonstrates that a line working at a normal pressure of 30,000 volts may, under such circumstances, be called upon to resist a momentary strain of 100,000 volts. The interesting feature is that the surge voltage is roughly a function of the current carried and proportional thereto, whence it follows that on account of the smaller current required with higher voltage the author summing up declares, "My experience shows that it is easier to operate a line, say from 30 miles up, at from 50,000 to 60,000 volts than from 25,000 to 30,000 volts, assuming that a considerable amount of power is transmitted." The discussion on Prof. Baum's paper is too long even to summarise in a review, as it extends over 12 pages of small print: it is, however, extremely interesting and instructive, and well repays the reader for the time spent in perusing it.

The present position of high tension transmission is well summarised in the paper of Dr. Perrine which follows, and the important subject of the line insulators is dealt with in subsequent papers by Mr. Converse and Mr. Gerry. It may be noted that up to 10,000 volts insulators whether of glass or porcelain have a minimum diameter of about 5 in. A 7-in. insulator can be successfully used on voltages as high as 25,000 volts. A 13-in. insulator is sufficient up to 40,000 volts, while at 60,000 volts it does not seem safe to install insulators having a less diameter at the top than 14 in. The insulators designed for all the California Gas and Water Co.'s new work at 60,000 volts have a dome 14½ in. in diameter, and, in addition to the dome, three petticoats. The older insulators of the Bay Counties Co., which the above will replace, had a dome very shallow in the dishing—12 in. in diameter, and with only one deep petticoat. The insulator used for 50,000 volts at the Shawinigan Falls has a 10½-in. dome and two petticoats, while the Guanajuato insulators for 60,000 volts have a 14-in. dome and three petticoats in addition.

Papers on the use of aluminium as an electrical conductor, and on the material to be used for conductors for long spans, add to the general fund of information, while the practical value of such papers as Messrs. Kelly and Bunker's on "Some Difficulties in High-Tension Transmission and Methods of Mitigating Them," and Mr. Hayward's on "Some Practical Experiences in the Operation of many Power Plants in Parallel," cannot be over-estimated. As Mr. Hayward says, the technical papers are full of articles describing and illustrating plants and the physical difficulties encountered in building them, but very little has been written about their operation. These papers are largely occupied with difficulties and troubles experienced and overcome, and a more useful treatise on electric power transmission than is furnished by the collection could scarcely be written. Needless to say, the book should be at hand in the office of every engineer who deals with transmission work.

Electricity in Homes and Workshops. By S. F. Walker. London: Whittaker & Co. Price 6s.

The fourth edition of Mr. Walker's practical treatise on electrical apparatus contains a vast amount of information on a tremendous number of subjects, ranging from burglar alarms and cigar lighters on the one hand, to steam dynamos and main switchboards on the other. The scope of the work will be realised when we say that fig. 156 is a glazed porcelain fitting for the inside of an Armorduct distribution box, while fig. 158, a page or two further on, represents a high-speed compound enclosed engine directly connected to a G.E.C. generator. In fig. 160 we have a 12-circuit main switchboard by the Wallsall Electric Co.; fig. 167 is a section of a three-phase cable with lead covering; fig. 173 is a saucepan; and fig. 190 is the stator of a Brush polyphase motor.

The volume at first sight has the appearance of being an abridged edition of the General Electric Co.'s catalogue, and we would not recommend the prospective reader to scan all the pages at one sitting, as we have done, unless he is prepared for a stiff bout of mental gymnastics.

Mr. Walker, in thus collecting a couple of hundred trade electros and spreading them over 350 pages, incurs a great deal of responsibility, and renders himself liable to very sharp criticism. The title "Electricity in Homes and Workshops" is surely sufficiently comprehensive, and one would think that the space at Mr. Walker's disposal could have been satisfactorily filled without the introduction of such irrelevant matter as mining signals, water level indicators, or cotton spinning machinery. Unless the author is a veritable encyclopædia he cannot pose as an authority on all of the subjects which he writes about, and we hardly know where to take him seriously and where not. It is true that the greater proportion of the information which he supplies could equally easily be derived from the manufacturers' catalogues, but, nevertheless, a number of errors have crept in. It is an easy matter in these days to collect a lot of trade cuts and "write round them;" in fact, an increasing proportion of our electrical literature is, alas, being manufactured in this manner. The least that the author (!) can do, is to see that the blocks are put in the right way up and accurately labelled, and that the descriptions relating to them are correctly copied. But Mr. Walker goes further than this. There are quite a number of illustrations requiring explanations which have apparently been put in as make-weights, and are not referred to in the text at all.

In the electric lighting section, for example, one of the most interesting illustrations is the diagram of the Union Co.'s direct-current flame arc lamp in fig. 105. The diagram is lettered, and as it stands it is quite meaningless without the concise explanation that is given in the catalogue from which the electro was taken. Yet we can find no reference to it in the text whatever, and a score of similar instances might be given.

In the section on electric motors, fig. 191 is described as another form of the B.T.-H. Co.'s motor-starting switch. The rheostat in question is not accurately described as a starting switch, nor, as a matter of fact, has it any associations with Rugby. It is a shunt regulating switch with a few starting contacts, and is produced by the Adams Manufacturing Co., but this trifle does not worry our author (!), who goes on to describe one of Messrs. Geipel and Lange's automatic starters, illustrated in fig. 193. Now, if Mr. Walker were familiar with the construction of a self-acting solenoid rheostat he would know that if he fixed the apparatus as shown in the picture, and then switched on, his career as a text-book writer would be curtailed. The rheostat is shown upside down, and if a reader of "Electricity in Homes and Workshops" fixed the gear as shown in fig. 193 he would get soaked with oil from the upturned dash-pot, and would then have the additional excitement of a dead short on his motor.

In the preface "the author suggests that students who find some of the problems with which they are faced in their studies puzzling, may be assisted by the explanations given

in the present edition." We would suggest that the student is likely to be still more puzzled, and we hope that the re-writing and revising of the fifth edition will be more successful than the rewriting and revising of the fourth.

SOME PRACTICAL NOTES ON THE COMMERCIAL DEVELOPMENT OF ELECTRICITY SUPPLY UNDERTAKINGS.

By R. BORLASE MATTHEWS, Wh. Ex., A.M.I.C.E.

"Direct-by-Mail" Advertising.*

Mention has been made of the comparatively recently introduced method sometimes known as "Direct-by-Mail" advertising. This consists in the systematic posting, at regular intervals, of a series of personal circular letters, folders, booklets and post cards. It is a very successful scheme, and keeps the service of the central station continually before those to whom they are sent. A monthly magazine serves its function by imparting information of an educational nature, but it is also of prime importance to keep on jogging the memory of the recipient in the interim, which can very effectively be done by such a system. Matter for a purpose of this kind must be attractive enough to stand out amongst the pile of advertising received in the daily mail, and interesting enough in appearance to cause the receiver to glance at it long enough to appreciate the fact that the central station wants his custom.

To take advantage of this system, the assistance of the advertising concerns must be sought, for the cost of the preparation is beyond the reach of the average central station, owing to the small quantities required, whereas the advertising companies, by syndicating the matter, are able to supply the same at low prices.

For the proper and economical distribution of direct-by-mail advertising, a carefully prepared and up-to-date mailing list must be used. Undoubtedly the best way of keeping this mailing list is to employ one of the several addressing machines on the market, the best types being those in which the addresses are on separate holders, and therefore can easily be corrected, and serve as an index in themselves, when put away in the cases. The face of the letters should preferably be in imitation of typewriting, as it impresses the recipient better than stencil. The addresses should be prepared from the main card index mentioned at the commencement of this paper, but divided up into three main sections: (S) shops and business places, (R) residences, and (P) power users. In the case of present customers, their rotation number should appear on the address, together with a distinguishing letter, say S, R and P respectively, to indicate which section they belong to, should the address holders by any chance get out of place. As is suggested for the main card index, each of these sections should be arranged in alphabetical order of the streets.

It may at first seem somewhat expensive to recommend the adoption of a machine of this kind, but it is a labour-saving device, and it must be remembered that a customer's name has to be written out at least three times a month or quarter, namely, on the bill, the voucher, and the envelope, and as regards the other addresses, they are first wanted for the advertising matter, and then owing to the inauguration of the new business department it will not be long before a very large percentage of them will be converted from prospective to actual customers.

In a case of hurry to get some special advertising matter circulated through the city, the machine is invaluable, as the addresses can be run off very quickly.

Some of the advertising concerns offer to take charge of the postal work, but it is usually preferable to post locally, so as to get the post mark of the home town on the wrapper, for attention is not then unnecessarily drawn to the fact that the work is done by outsiders. Circular letters and form letters should be dispatched with a penny stamp and printed in imitation typewriting.

Dealing with Inquiries.

As the newspaper and mail advertising campaign will be bringing in inquiries before the canvassers have completed their preliminary systematic canvass of the territory, arrangements must be made for taking prompt and proper care of them; the canvasser from whose territory the inquiry emanates being advised to look it up as promptly as possible.

The canvasser in making out the report of each call should indicate whether the occupant was (1) not at present interested, (2) partially interested in (L) light, (H) heat or (P) power. The object of this being to possess a record which shall form a guide as to the advertising literature that should be sent to arouse interest or to bring past the stage of partial interest. The remaining case, the interested party is, of course, at once taken care of, and, if possible, converted into a customer—if this cannot be done he should be classed as "partially interested." As this information is obtained, the plates of the addressing machine should be sorted out accordingly. A card index, which is a duplicate of the address plates of the addressing machine should be prepared and arranged in the same way, so that the three main sections, *i.e.*, the S list (shops and business places), the R list (residences) and the P list (places where power is used) will now each have been divided into six sub-sections, indicated as below :—

Mark.			Indicates that the addressee
S List.	R List.	P List.	
S (1)	R (1)	P (1)	Is not at present interested.
S (2)	R (2)	P (2)	Is partially interested in light, heat and power.
S (2L)	R (2L)	P (2L)	Is partially interested in light.
S (2H)	R (2H)	P (2H)	Is partially interested in heat.
S (2P)	R (2P)	P (2P)	Is partially interested in power.
S	R	P	Is a customer.

Every day a council of war should be held, the manager and his assistants meeting to talk the general situation over, in this way notes can be compared, and in the case of certain as yet undecided prospects, very often some of the staff may know of some local or friendly influence that might be of considerable assistance in obtaining the required decision.

Canvassers.

As the new business department advances, it will be found necessary to get more canvassers into the field, so that more frequent calls may be made and no prospective customer neglected in any way.

The question arises as to where the new canvasser should be obtained, the terms of payment he should receive, and whether he should be a local man or a stranger. With an outsider it will necessarily be a couple of months before he acquires the requisite local knowledge, but on the other hand, he is probably accustomed to the work, having been selected on that account. As a stranger, he will often interest people and get new business that the local man cannot get. Yet the local man has also many advantages in his favour, so that if he has the qualities required for a successful salesman and has sufficient knowledge to enable him to offer suggestions and answer the technical questions that are sure to arise, he will be able to do good work. Evidently, therefore, part of the staff should be outsiders and the others local men.

The large manufacturing companies usually have men in their employ, training as salesmen, who would be glad to accept a position as a canvasser. These men are valuable, as their technical training is as a rule sound. A man who has had some experience as a commercial traveller usually makes an excellent canvasser with a little training.

A canvasser usually receives a salary which is assumed to be sufficient to cover his living expenses, and then a commission is paid on all new business secured, beyond, say, 500 8-c.p. lamp equivalents per month. This commission may be a flat amount per 8-c.p. lamp equivalent per customer

* Previous articles of this series appeared on pages 650-1, 656-7, 827-9, and 808-9 of the current volume.

secured, or better still, a graded rate, depending on the value to the central station of the new business obtained.

It is not advisable as a general rule to give a percentage on sales of apparatus, as it might often be a temptation for the canvasser to sell things that are not to the best advantage of the customer.

A modified commission scale should be open to employés other than the canvassers, to encourage them in persuading their acquaintances to become customers. At the same time it should be clearly pointed out that when some one is interested in this way, assistance should be sought to close the deal. The understanding being that the commission will be paid to the man starting the business, even if it is finally closed by the manager or some other officer.

As an encouragement to employés to put forth their best efforts, a list of new customers should be posted up each month in the office together with the name of the man who obtained the new business, recognition of this sort generally being much appreciated.

Another commission scale should be prepared for wiring contractors, with the commission payable preferably one month after the installation has been in use.

ENERGY UNITS AND THE VALUE OF A KW.-HOUR.

Seeing that most of the power of the world is at present derived from heat engines, it would appear rational that the heat unit should be the universal unit of comparison. A recent correspondent of the Electrical Review is dissatisfied with the heat unit, and wants all energy, potential or otherwise, to be stated in terms of the kilowatt-hour. This is a curious attitude to take up, and would be paralleled by the locomotive engineer who should ask for coal values to be stated in terms of Beattock incline. The horse-power-hour is equivalent to 2,564 B.TH.U., according to Rowland's mechanical equivalent of heat; therefore the heat equivalent of the kilowatt is 3,412 nearly, whence it can briefly be stated that 1 lb. of first-rate bituminous coal is about equivalent to 4 KW.-hours. Since in usual practice 1 KW.-hour rarely requires less than 4 lb. of coal, the efficiency of conversion is evidently about $1 \div 4^2$, or, say, 6 per cent. Considering that energy is available as heat, the heat unit—British or metrical—is the most rational unit for all purposes, and the jumble of fresh units that each fresh industry usually feels conceited enough to adopt should not be necessary. All energy is derived from heat whether of fuel or the sun, and all energy practically returns to heat.

The equivalence of heat and mechanical energy has been very closely determined by Joule, whose original figure of 772 ft. lb., when corrected for Joule's thermometer, is practically the same as Rowland's figure of 778 ft. lb.

The value of coal is better expressed in heat units than in KW.-hours, because five whole numbers alone are necessary. If expressed in kilowatts at least 3 decimal places would follow the whole number 4, or 3, as might be the case with a poor coal; and even 4 decimals might be thought needful by some.

It begs the whole question to advance candle-power as an argument in favour of the kilowatt-hour. The candle-power of an electric light comes directly from heat supplied by the electric current. Why, therefore, proceed to divorce the electrical energy from the heat energy whence it is so immediately derived. The mechanical equivalent of heat was worked out at great labour in order to enable the B.TH.U. to be used as a unit. It, or the calorie, is the simplest of units, and expresses a very simple ratio—namely, the heat equivalent, of making 1 lb. or 1 kg. of water hotter by 1° F. or C., so that the calorie is almost exactly 4 B.TH.U.

So far from dropping the heat unit, why not cease floundering about with a heterogeneous collection of patched-up units, and at once express electrical energy in its equivalence of heat units? thus, in a far simpler manner, at once being able better to express efficiencies all along the line, than by starting at the tail end and working back to coal.

The energy of water power is so readily convertible into its heat equivalent that similar comparative results and direct efficiencies may be deduced in respect of the electrical output from a fall of water.

Since the KW.-hour is 3,412 heat units, the KW.-second is very nearly 1 heat unit. In all power station work the heat unit is the only admissible unit. It not only serves to state the calorific capacity of fuel, but is required in connection with all the calculations concerning the boilers, the feed heaters, condensers, cooling towers or ponds, and the KW.-hour would be a ridiculous unit to employ in all these matters. This electrical unit is derived somewhat indirectly from the heat unit, but it has nothing to recommend it for a separate name as an original unit, whereas the two heat units are so directly associated with the universal element of water and the source of all power, heat, &c., that there can surely be no two opinions as to the place that should be occupied by the thermal unit.

The kilowatt is a derivative from the days of what may be called the small things of electricity, the days when it was little else than a scientific toy. So also the C.G.S. system is of too small a conception to suit these days of dynamically produced electrical energy, but those who care for the mechanical statement of a unit might follow Rankine and use, as he often used, the foot-pound instead of the heat unit, though the heat unit seems simpler, and comes before the foot-pound where the heat engine is concerned. It has the further advantage that every step in power generation would be correlated to the initial energy in thermal units supplied with the fuel.

It might be as well if a legal definition were given to the mechanical equivalent of heat, so as to eliminate the small discrepancies which now are apt to arise between the old and new accepted values. The difference is small, and no one would quarrel over any value from the minimum to 780. The heat unit is of long standing as a closely determined value in foot-pounds, yet is strangely neglected. Men in charge of many thousands of horse-power often absolutely ignore it and prefer to talk in terms of weights of coal. Questions of heat, specific heat and temperature often seem to become hopelessly mixed, and this unfamiliarity with the primary unit is doubtless responsible for much of the poor practice in heat engineering which is so prominently displayed. Surely the thermal unit is an all-sufficient unit for all purposes of power engineering. Its use need not necessitate the statement of results in large figures, for it could be used in its multiple of 1,000, or even 10,000, to which instruments would be graduated. Thus, in a power house the weigh bridge would record the value of the coal passed over it in thermal units, and the automatic coal meters at the boilers would be set to measure off thermal units, not merely so many pounds of coal, but the equivalent, determined from test or analysis, in thermal units.

The output of the station would be registered in the same unit instead of in KW.-hours. The voltmeter and the amperemeter would remain, as would the steam gauge and the watermeter, useful instruments but not registers of output.—W. H. B.

The Production of Aluminium.—The increase in the price of aluminium from slightly over 2s. to 4s. per kilogramme, which took place in the autumn of 1905, was mainly due to the larger consumption, which set in almost at the same time as the outbreak of labour troubles at the aluminium works in France. When the French strike ended and the general production reached its former level, the quantity of aluminium available was still scarcely able to meet the demand, and the price remains at about 3s. 6d. per kilogramme. The Pittsburg Aluminium Co. is reported to have sold out for the present winter, and American makers of aluminium articles have failed to secure supplies of the metal from European works. The Neuhausen Aluminium Co. is carrying out extensions which will materially increase the production, and a works is to be erected in Italy for an annual output of from 600 tons to 800 tons.

LOCAL AUTHORITIES AND THE SUPPLY OF ELECTRICITY.

[FROM OUR LEGAL CONTRIBUTOR.]

A CORRESPONDENT has recently drawn attention to a very curious *impasse* which has arisen in relation to the supply of electricity within the Rural District of Felixstowe and Walton. In view of the importance of the point at issue, it may be well to recapitulate the facts.

In 1902, the Felixstowe Rural District Council obtained a provisional order for the supply of electricity in their district. In 1903 they entered into an agreement with the Suffolk Electricity Supply Co. to erect the necessary works. This involved an outlay of £8,000, £5,000 being payable on the execution of the agreement, and £3,000 when the company had complied with certain conditions. Pursuant to Sec. 11 of the Electric Lighting Act, 1882, the clerk of the Council forwarded a copy of the agreement to the Board of Trade for their sanction. The section provides, in effect, that a local authority, having obtained a provisional order, may contract with any company or person for the execution of the necessary works, but "no local authority . . . . shall by any contract . . . . transfer to any . . . . company, or divest themselves of any legal powers given to them or any legal liabilities imposed on them by this Act or the provisional order without the consent of the Board of Trade." The Board of Trade replied, stating that contracts made under the section for the execution of works for supply of energy did not require the consent of that department. When the Council obtained the provisional order, they applied to the Local Government Board for sanction to raise a loan for the purpose of paying the £8,000. The Local Government Board allowed a loan of £5,000, but declined to sanction the raising of £3,000 until the conditions were complied with.

The conditions having been duly complied with, the Council in 1906 applied once more to the L.G.B. In the meantime a case known as the Sudbury case had come before the courts, in which it was held that an agreement similar to that above referred to must be sanctioned by the Board of Trade. Relying on this decision, the Local Government Board refused to sanction the loan of £3,000. The company began to press for payment, and with the laudable desire to save the ratepayers the unnecessary costs of litigation the Rural District Council paid over the amount.

As in duty bound, the auditor has refused to sanction the payment, and the unfortunate Councillors find themselves surcharged to the extent of £3,000. That the auditor could take no other course is made plain by Sec. 247 (7) of the Public Health Act, 1875. It is there provided that an auditor must disallow every item of account which is contrary to law, and surcharge the same on the person making or authorising the making of the illegal payment, and must charge against any person accounting, the amount of any deficiency or loss incurred by the negligence or misconduct of that person.

If the Local Government Board refused to sanction the loan of £3,000, the auditor had no other course open to him. He pointed out that the Council would, no doubt, appeal to the Local Government Board, but this would, in effect, be a request to that Board to reverse its own decision.

The right of a person who is aggrieved by a surcharge to appeal to the Local Government Board is regulated by a Local Government Board Order, made in April, 1885. It is there provided that the Board upon appeal being made to them, are empowered to decide as to the lawfulness of the reasons stated by the auditor for the disallowance or surcharge, and where they uphold his decision, they may upon payment of the costs, if any, incurred by the auditor in taking steps to enforce payment of the money certified, remit the disallowance or surcharge, if they consider that the subject matter thereof was incurred under such circumstances as make it fair and equitable that this course should be taken.

It is interesting to refer to the facts of the case, the decision of which gave rise to all this confusion.

It would seem to be clear from the case of Sudbury Corporation *v.* Empire Electric Power Co. (1905) 2 Ch. 104), which was decided in April of last year, that the agreement in question should have been submitted to the Board of Trade. It appears that a corporation obtained a provisional order for the supply of electrical energy within their district. They entered into an agreement with the defendant company, which provided that the company should construct all necessary works for the manufacture, supply and distribution of electricity within the area of supply, and should manufacture, distribute and supply electricity therein; carry on the business and indemnify the corporation against all expenses; and that nothing in the agreement was to be deemed to transfer to the company any powers which the Corporation were by the order or by the Electric Lighting Acts, 1882 and 1888, prohibited from transferring. No application was made to the Board of Trade to sanction this agreement. The company did not construct the works, and the Corporation brought an action against them for damages for breach of contract. It was held by Mr. Justice Warrington that the first part of Sec. 11 of the Electric Lighting Act, 1882, only authorised a corporation which had obtained a provisional order for the supply of electricity, to enter into contracts for the construction of works and for the supply to itself of electricity; that the second part of the section prohibited corporations, and also companies and persons who had obtained orders, from transferring to other persons or divesting themselves of any legal powers given to them, or any legal liabilities imposed on them by the Act or the Orders, without the consent of the Board of Trade; that the agreement was, on its true construction, a transfer of the duties and liabilities of the plaintiff Corporation to the defendant company; that it was, therefore, prohibited by the section, and could not be enforced.

A well-informed correspondent has informed us that the Felixstowe agreement is totally unlike that which is under discussion in the Sudbury case, inasmuch as the company have merely contracted with the Council to carry out certain works and maintain them. The Council remain the undertakers and collect the revenue. In these circumstances it would seem that the Board of Trade were perfectly right in their first decision, namely, that they were not called upon to give consent. If this be the correct view, there was nothing to prevent the Local Government Board giving their sanction to the loan. If they had done so, a large amount of expense and trouble would have been saved to the councillors.

LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names may be made. Answers are furnished by a barrister-at-law.*]

No. 60.—Corporation and Consumer.—Cost of Main Fuse.—Duty of Corporation to invite Tenders.

"FUSE" writes:—"I shall esteem it a favour if you can give me information on the following points:—

"(*a*) Is a corporation within its legal rights in charging customers for a main fuse which is the only one between their mains and their meter? The fuse is a sealed fuse which customer may not touch.

"(*b*) Is it legal for a corporation electric supply department to purchase largely without inviting tenders? If advertising for tenders be essential, in what class of publication ought such advertisements to appear?"

*** With regard to (*a*) there is not, so far as can be ascertained, any special provision in the schedule to the Electric Lighting Clauses Act, 1899, relating to the provision of main fuses. It would appear that the question whether the customer shall pay for it or not, depends upon the terms of his contract with the corporation. With regard to (*b*) it is provided by the Public Health Act, 1875, Sec. 174 (4) that before any contract of the value or amount of £100 or upwards is entered into by an urban authority, 10 days' public notice at the least shall be given, expressing the nature and purpose thereof, and inviting tenders for the execution of the same; and such authority shall require and take sufficient security for the due performance of the same. The Public Health Act does not contain anything which specifies the class of paper in which the advertisements in question should be published.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

21,947A/05. "Improvements in and relating to dynamo-electric machines." S. von Ammon. (Date applied for under Rule 5 of the Patents Rules, 1905, October 27th, 1905.) November 7th.

3,119A. "Improvements in liquid interrupters." A. C. J. Guenee. (Date applied for under Rule 5 of the Patents Rules, 1905, February 8th, 1906.) November 7th. (Complete.)

24,727. "Improvements in electric bells." H. Bevis and A. E. Mitchell. November 5th.

24,733. "Improvement in brushes and brush-holders for dynamo-electric machines." F. H. Loring. November 5th.

24,756. "Improvements in electric rail and tramways." J. Thewlis. November 5th. (Complete.)

24,806. "Improvements in and connected with electrodes for electrolytic purposes." P. Ferchland. (Date applied for under Patents Act, 1901, November 9th, 1905, being date of application in Germany.) November 5th. (Complete.)

24,820. "Improvements in electric furnaces." A. Reynolds. November 5th.

24,847. "Improved auto-commutator for alternating currents." F. M. E. Pinot. (Date applied for under Patents Act, 1901, December 6th, 1905, being date of application in France.) November 5th. (Complete.)

24,861. "Permeated electric arc lamp carbons and electric incandescent lamp filaments." J. Willis and B. Johnson. November 6th.

24,923. "Improvements in or in connection with the control of the electric circuits in systems of electric traction or haulage." J. S. Raworth. November 6th.

24,927. "Attachments or appliances for use in connection with the cables or wires of automobile ignition systems and for similar uses." F. H. Hall. November 6th.

24,934. "Improvements relating to ignition devices for internal combustion engines." J. C. Dennis and R. Dennis. November 6th.

24,950. "Gravity-fed arc lamp." F. Blanckenese, G. McMullen and F. Mosey. November 6th. (Complete.)

24,968. "Improvements in and relating to dynamo-electric machines." The British Thomson-Houston Co., Ltd., and W. F. Dawson. November 6th.

24,973. "Improvements relating to electric incandescent lamps." A. Lederer. November 6th.

24,985. "Improvements in and relating to the electrolytic deposition of metals." S. O. Cowper-Coles. November 6th.

24,986. "Improvements in and relating to the electrolytic deposition of metals." S. O. Cowper-Coles. November 6th.

24,995. "Improvements in or relating to self-acting starting resistances for electric motors." M. Kallmann. November 6th. (Complete.)

25,143. "Improvements in multiple-way electrical switches." A. P. Lundberg, G. C. Lundberg and P. A. Lundberg. November 8th. (Complete.)

25,152. "Improvements in process of electric welding." L. S. Lachman. November 8th. (Complete.)

25,178. "Improved means for securing and adjusting incandescent electric lamps and reflectors to posts and masts for use in the illumination of shop windows." E. J. Smith. November 8th. (Complete.)

25,198. "Improvements in connection with current collectors for vehicles or trains, running on electric railways or tramways with overhead conductors." P. Dawson. November 8th.

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25,202. "Improvements in and relating to controllers or switches." The British Thomson-Houston Co., Ltd. (The General Electric Co., U.S.) November 8th.

25,203. "Improvements in and relating to electric motor control systems." The British Thomson-Houston Co., Ltd., and H. N. Sporborg. November 8th.

25,204. "Improvements in and relating to electric transformers." The British Thomson-Houston Co., Ltd. (The General Electric Co., U.S.) November 8th.

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Optical and Electrical Investigations of Passivity.

A paper was read by Dr. W. J. Müller, of Mülhausen, before the last meeting of the German Society of "Naturforsche und Aertze," held in Stuttgart during the autumn, in which the author described certain optical and electrical measurements he had carried out upon the phenomena existing at the surface of contact between a metal and an electrolyte. The optical tests consisted in the examination of the reflective power exhibited by metallic mirrors when carrying different electrical charges, and in attempts to ascertain the optical and electromotive effect of thin layers of oxides, metals, and gases; also in endeavours to discover whether the phenomena taking place at the surface of contact between a metal and an electrolyte could be detected and studied optically. When a gaseous alloy was obtained upon palladium by the action of electrolytically separated hydrogen, it was found that the palladium mirror was attacked by sulphuric acid, yielding a brown film of palladious or palladic oxide, which greatly reduced the reflecting power. Anodic polarisation caused the palladium to become passive, and to resist the action of sulphuric acid, so that when possessing slight anodic polarisation the palladium retained its reflecting power unaltered. This fact shows clearly that the passivity of the palladium has nothing to do with the presence of an oxide layer. The formation of the hydrogen alloy actually increased the reflecting power to a small extent.

When aluminium mirrors suffer anodic polarisation, the reflecting power is permanently lowered, corresponding with the well known production of a film of hydroxide upon the surface. As the result of the experiments, it may be said with certainty that the passivity of iron, nickel, chromium and palladium (which last has not been observed before) is not due to the formation of layers of oxide upon the respective metals.

In a second paper communicated to the same Society, Dr. Müller offered some suggestions towards the elaboration of a theory of passivity. He considers that passivity is a function of the metal only, and consists in a sudden alteration of the equilibrium between the metallion and the electrons. In its normal or stable condition, the metal contains ions of the valency which is most stable in aqueous solution—*e.g.*, divalent ions in the case of zinc, tetravalent ions in that of platinum. If now the discharging tension of an ion is less than the tension necessary to drive the ion out of the metal into the solution, the metal behaves as an insoluble electrode. Chromium, for example, is an insoluble electrode in potassium iodide solution, but dissolves in potassium chloride solution, yielding hexavalent ions.

It may, therefore, be said that if the metal normally gives ions of low valency, its active condition is stable, and its passive condition unstable or metastable; but if in its normal condition its ions are of high (divisible) valency, the passive state is the normal, and the active is metastable. When arranged in electromotive series, the stable low-valent metals are at the positive end, and the stable high-valent metals at the negative end. For instance, magnesium, zinc and maganese, which stand close to the positive end of the series, can only with much difficulty be rendered passive. Later on in the series, the metals are able to exhibit higher valencies if exposed to the action of a certain P.D., and so they become passive as long as the necessary current is flowing, but return to their active state as soon as the current is interrupted. The metals that lie nearer the middle of the series, such as iron, nickel and cobalt, are easier to render passive; or, as the phrase generally goes, a larger number of electrolytes make them passive. By the time chromium, molybdenum, &c., are reached, the conditions are reversed: anodes of these metals are passive in all electrolytes, the active state is metastable, and disappears in time. Metals like platinum at the negative end of the electromotive series can only be rendered active by special arrangements. According to this explanation it is easy to see that the passivising action of the same anion is very different when applied to different metals. Certain minor aspects of the phenomena of passivity, such as velocity, &c., still require to be studied in detail, but in the meantime the author feels that he has succeeded in indicating the broad lines of a theory of passivity.